University of California
College of Agriculture
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# ECONOMICS OF MECHANICAL COTTON HARVESTING IN THE SAN JOAQUIN VALLEY - 1949

by

Warren R. Bailey, and Trimble R. Hedges

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Results of a cooperative investigation conducted
by the Bureau of Agricultural Economics and the
California Agricultural Experiment Station

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This preliminary report is based on a projected two-year study of the economics of mechanical cotton harvesting in the San Joaquin Valley. The first year's work included a survey of the costs of machine picking and collection of data relating to the effect of machine picking on cotton grades and gin turnout. The second year's work will further investigate machine-picked cotton grades and their economic implication to the cotton grower. The study is being conducted cooperatively by the California Agricultural Experiment Station and the Bureau of Agricultural Economics. The study is supported in part by funds appropriated under the Research and Marketing Act.

## ACKNOWLEDGEMENTS

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## CONTENTS

# ECONOMICS OF MECHANICAL COTTON HARVESTING
# IN THE SAN JOAQUIN VALLEY, 1949

by Warren R. Bailey and Trimble R. Hedges [1]

## INTRODUCTION

Mechanical cotton harvesters have operated commercially six years in the San Joaquin Valley. Used first in the south and on the West-side, their use quickly spread to other areas until in 1949, nearly 900 machines harvested some 15 percent of a record 1.3 million-bale cotton crop. Some growers have converted completely from hand to machine picking, others use machines merely to supplement hand picking. In general, the 1949 season proved to many growers that mechanical harvest is both practical and economically feasible for them. Improvements in machines, in operating techniques, and in growing the cotton crop have made successful mechanical harvest possible. Growers, individually, have used mechanical harvesters with varying degrees of success. Some have said that machine picking results in such high field waste and such low grades as to be economically impracticable while others merely reported disappointing results. On the other hand some growers reported resounding success. Obviously, the true situation had to be somewhere between these two extremes.

This study was undertaken to assemble information available and to fill in the gaps with new information necessary to evaluate the economic feasibility of machine harvesting. In earlier years, most of the harvesters were bought by the larger growers who were financially able to experiment with mechanization. Henceforth, more and more of the smaller growers will consider conversion to machine harvest, either by purchasing a machine or employing a custom harvester. They need systematic information to decide whether such a shift is practicable for them individually. Again, the grower who already has a machine will be interested in comparing his results with some average or standard. The results reported will indicate whether his operation is good or poor compared to the experience of growers surveyed in 1949.

Following the 1949 harvest season enumerators interviewed 63 growers selected at random from among those who owned and operated one mechanical harvester.[2] Growers interviewed were located in five sub-areas considered

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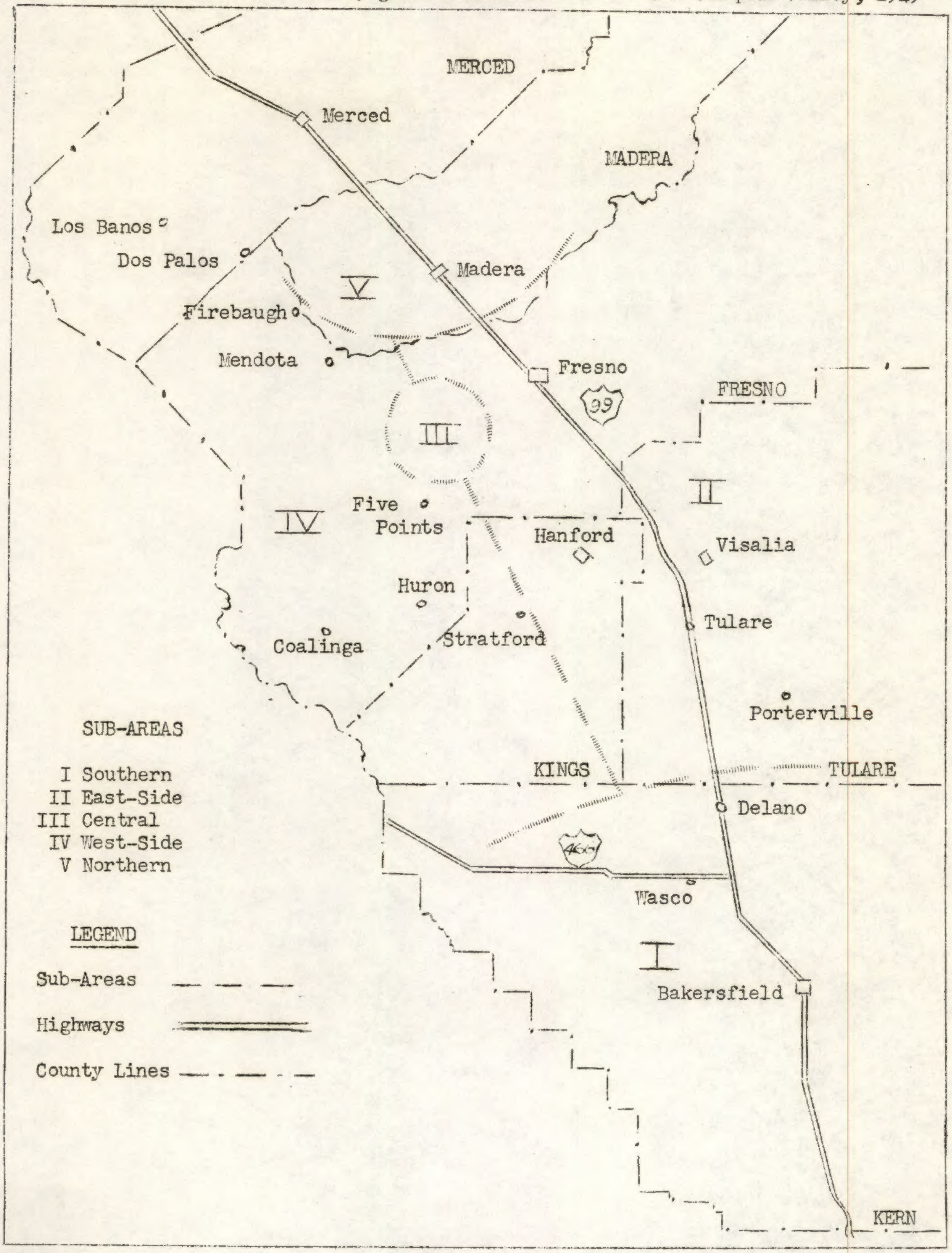
[1] Respectively, Agricultural Economist, Bureau of Agricultural Economics and Associate Professor of Agricultural Economics, Associate Agricultural Economist in the Experiment Station, and Associate Agricultural Economist on the Giannini Foundation of Agricultural Economics, University of California. Chester O. McCorkle, Jr., Assistant Specialist in the Experiment Station assisted in collection of the data and in certain phases of the analysis.

[2] One make of harvester was studied, the only one commercially available to farmers at that time, a one-row, spindle type machine with two drums, mounted on a general purpose wheel tractor.

to represent typical production situations in the San Joaquin Valley (Figure 1). Information obtained from them included machine-hours operated, pertinent costs and man-hours used. Data also were taken from gin statements for growers regarding weight of seed cotton, weight of lint, and bale numbers (so that the exact grades of any given lot of cotton could be learned) for both the machine-picked and the hand-picked cotton. These gin data permitted a comparison of both gin turnout and lint grades of the cotton from the two methods of harvesting. In addition, the grades were ascertained of 62,623 machine-picked and 237,811 hand-picked bales at 35 gins located in various areas of the valley.

The present report is preliminary, to be followed by a more thorough study of the data and a more detailed report. We believe the information is of immediate value to growers and the cotton industry.

FIGURE 1. Sub-areas studied; general location in the San Joaquin Valley, 1949



The 63 growers interviewed were located in five sub-areas of the San Joaquin Valley.

## SUMMARY

Machine cotton picking did not get under way in the San Joaquin Valley until mid-October in 1949 when about one-fifth of the cotton had already been harvested by hand. Machine picking was delayed because cotton had not defoliated. The chemical defoliants used were not completely satisfactory. A typical grower began picking October nineteenth and finished January first. He operated his machine 47 working days or 407 machine-hours. He covered 284 acres (145 first picking and 139 second picking) and picked a total of 229 bales. He picked 3,183 hundredweight of seed cotton, equivalent to the output of 1,250 man-days of hand picking.

The use given the 63 machines studied, varied considerably. Thirty-two machines were operated fewer than 400 hours, somewhat under a full season's use. Some growers using machines for the first time did not venture into first picking, others used machines merely to supplement hand picking, or bought their machines after the harvest season had begun. But 31 machines were given approximately a full season's use. They were operated an average of 520 hours and picked 292 bales in 356 acres of picking. From this a grower can expect a machine to harvest completely 200 acres of cotton and pick about 300 bales in two pickings. During the 1949 season, mechanical harvesters were used more in first picking than ever before. All but four of the 63 growers used their machines in first picking and all but two did some second picking. Eleven harvested all their cotton with machines averaging 263 bales in 268 acres of picking.

Mechanical harvesters picked, on the average, 0.60 acre per machine-hour in first picking, and 0.89 acre in second picking. Pick per hour amounted to 1,021 pounds of seed cotton in first picking and 429 pounds in second picking. Pick per workday averaged 7.0 bales in first picking and 2.3 bales in second picking. Over the season, the average pick was 4.9 bales per day operated.

Growers reported they had fewer break-downs and kept their machines operating more of the time in 1949 than in previous years because they understood better the mechanical requirements of the machine. They anticipated the most needed replacement parts and stocked them. A major contribution to this more successful operation and maintenance was the Operator's Schools conducted jointly by Farm Equipment Dealers and the Agricultural Extension Service at the beginning of the season.

Gin turnout of machine-picked cotton (36.5 percent) averaged less than one percentage point lower than the turnout of hand-picked cotton (37.1) among the 63 growers. It required 1,370 pounds of machine-picked seed cotton compared to 1,348 pounds of hand-picked seed cotton to make a 500-pound bale of lint cotton. Turnout of the machine-picked was considerably below the turnout of hand-picked early in the season, it nearly equaled hand turnout in mid-season and was actually higher in late season picking. On the whole the turnout of the machine-picked was remarkably good.

Cost of machine picking for the 63 growers averaged $14.65 per bale harvested, $11.82 per acre of picking, and $8.25 per hour of machine operation. Highest cost per bale ($20.72) was in the northern area where an average of 158

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bales were picked, and the lowest ($11.71) was on the West-side where 292 bales were picked. A grower picking 200 acres of first picking and 150 acres of second picking, and harvesting 300 bales of cotton would have had an average cost of $7.36 per hour, $10.70 per acre of picking, and $12.49 per bale. Thus operating to capacity a grower can reduce his overhead costs per hour, per acre and per bale.

Overhead dominates the cost picture. Per-bale costs included $7.57 for overhead on harvester and tractor, $4.43 operating expenses, and $2.64 for labor. The purchase price of approximately $9,500 for harvester and tractor largely explains the high overhead costs. Annual depreciation charges were $1,483 and annual interest-on-investment were $217 for the equipment.

Optimum harvesting costs can be obtained only by maximum use of the mechanical harvester. Many growers did not get full use of their machines in 1949. Added experience, definite training for operators, and improved cultural practices favoring machine picking will reduce maintenance and repair costs and contribute to more hours of operation, thus lowering costs per bale. It is probable too, that the same factors will extend effective life of the picker, thus further reducing annual and per-bale overhead costs.

The economic advantage of machine picking embraces more than just the costs of machine-versus-hand picking. Because the grades of the machine-picked cotton were lower than those for hand-picked, the returns from a crop that was picked by machine were lower than they were for equal field cotton that was hand picked. Machine-picked cotton averaged, for the season, slightly less than one full grade below hand-picked cotton. The average grade-index of machine bales was 91.8, and of hand bales, 97.4. Thus, machine bales were concentrated in the grade of Strict Low Middling and hand bales, in Middling.

Machine-picked cotton also averaged lower in value than hand-picked cotton. As an indication, the government loan value of hand-picked bales averaged $142.84 and of machine-picked bales $132.52, a difference of $10.32 per bale. In the northern area machine bales averaged $19.75 per bale below hand bales; on the West-side the difference was only $8.06 per bale.

Seasonal trends of the grades of machine-picked and of hand-picked cotton were studied at eight gins located in different parts of the valley. At each gin, grades from the machined cotton averaged lower than the grades of the hand-picked in all periods of the season. But there was some tendency for the spread between grades of machine-picked and hand-picked cotton to narrow in late season picking. Another observation was that week-to-week fluctuations in grade were smaller in hand-picked cotton than in the machine-picked.

Difference between grades of machine and hand-picked cotton varied widely among gins. Variation is indicated by the range in spread of grade-indexes from 1.2 to 11.8, and in differences in loan value from $1.47 to $28.25. Even on the West-side, where machined cotton more nearly approached hand-picked cotton in the matter of grades, the range in differences was from $1.47 to $13.34 per bale.

The study also revealed wide variations among the 63 growers in the grades of their machine-picked cotton. The range in season-average, machine grade-

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indexes was from 82.7 to 98.8, or from less than Low Middling to Middling. It is significant however, that some growers in each area had high grades of machine-picked cotton. At least one grower interviewed in each sub-area had season-average grades of Strict Low Middling or better. These data suggest that cotton of good grades can be obtained by machine picking in all parts of the valley, but with more difficulty in some parts than in others.

Experimental results have shown that the over-all efficiency of machine picking was 96.5 percent and hand picking under similar conditions was 97.6 percent. These efficiencies indicate that in 1.5-bale cotton a mechanical harvester leaves 79 pounds of seed cotton per acre, whereas hand pickers leave 54 pounds, 25 pounds less than the machine. The field value of 25 pounds of seed cotton, in 1949, was about $1.82; this amounts to about $1.20 per harvested bale. Most growers said that machines did a more thorough job of "cleaning the field" than in previous years, and very few were any longer concerned about field waste. Growers also reported that field waste was relatively smaller in rank growing, high yielding cotton.

The economic advantage of machine picking is found by adding together costs of picking, value of grade-loss, and value of field waste, and comparing the sum with the total cost of hand picking. For the average grower, these may be summarized as follows:

| | Harvesting Costs Per Bale | | | | | | |
|---|---|---|---|---|---|---|---|
| | Hand | Machine Picking | | | | | |
| | Picking | San Joaquin Valley | South | East-side | Central | West-side | North |
| Picking costs | $45.00 | $14.65 | $12.86 | $14.15 | $15.77 | $11.71 | $20.72 |
| Field waste | --- | 1.20 | 1.20 | 1.20 | 1.20 | 1.20 | 1.20 |
| Grade-loss | --- | 10.32 | 10.85 | 14.72 | 11.68 | 8.06 | 19.75 |
| Total economic costs[1/] | $45.00 | $26.17 | $24.91 | $30.07 | $28.65 | $20.97 | $41.67 |
| Difference in favor of machine picking | --- | $18.83 | $20.09 | $14.93 | $16.35 | $24.03 | $ 3.33 |

[1/] Additional ginning costs, for machine-picked cotton, averaging about 11 cents per bale, not included.

The economic advantage of machine picking was smallest ($3.33) in the northern area because both harvesting costs and grade-loss were higher here than in the other areas. Economic advantage was largest ($24.03) on the West-side because both harvesting costs and grade-loss were below the average.

A practical economic question facing the grower is how much seed cotton per acre must he get to afford machine picking. For example, can he afford to pick cotton yielding 150 pounds of seed cotton (1/10-bale in case of second picking) per acre? In 1949, his <u>total</u> picking cost with the machine would have

been $6.47 per hundredweight of seed cotton worth $7.70 above ginning costs.[3] A grower who considered only the direct costs (excluding overhead) of mechanical picking could operate when the yield was only 75 pounds; his direct costs would have been $6.25 per hundredweight. In both of these examples, hand picking even at going rates for second picking (about $4 per hundredweight) would have been more economical.

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[3] With lint at 20 cents a pound and cottonseed at $45 a ton.

## USE AND PERFORMANCE OF MECHANICAL HARVESTERS

Before 1949, many growers had considered their machine harvesting as merely supplemental to hand picking. Many machines therefore had been used only in second picking or when hand workers were unavailable. Machines had been used to some extent in fields too weedy or too low in yield to attract hand workers. The lack of a successful chemical defoliant also had kept many growers from using machines until after the first heavy frost. Thus there had been no widespread effort to make maximum use of harvesting machines. But growers in general made a fuller use of mechanical harvesters during the 1949 season. The extent of use is indicated by data from the 63 growers interviewed.

### Summary of Machine Use

A typical grower began machine harvest on October nineteenth and finished January first. He operated his machine 47 working days during this 75-day period, a total of 407 machine-hours.[4] He covered a total of 284 acres once over; 145 acres of first picking and 139 acres of second picking. He picked a total of 229 bales, of which 182 bales were first picking and 47 were second picking. Each machine, on the average, picked 3,183 hundredweight of seed cotton, equivalent to the amount 25 hand workers would have picked in 50 working days.

Mechanical harvesters on the average were operated more machine-hours (479), covered more acres (317), and picked more bales (292) on the West-side than in any other area. Machines were used least in the northern area where they did the least first picking.

There was considerable variation in amount of use per machine. The range in total days operated was from 16 to 112, in machine-hours from 120 to 766, in acres of picking from 80 to 535, and in bales picked from 93 to 613. Some machines operated less than a full season, as might be expected, whereas others operated at near capacity. Study of the 63 individual records revealed that 31 machines operated more than 400 hours, or approximately a full season's picking. These 31 machines, on the average, operated 520 hours in 62 working days between October 11 and January 7. They picked an average of 292 bales from 356 acres of picking (182 acres of first picking and 174 acres of second picking).

All but four of the 63 growers used their machines in first picking and all but two growers did some second picking. Eleven growers picked all their cotton with machines. They picked an average of 263 bales of which 235 bales were first picking and 28 bales second picking. These growers had, on the average, 158 acres of cotton of which they second-picked 110 acres.

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[4] Machine-hours exclude morning, noon, and night service time and extended stops for adjustments or repairs, but include stops for minor adjustments or repairs, for unloading the basket, and for resting the operator.

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Table 1.- Operating season, days and machine-hours operated, and acres, bales and seed cotton mechanically harvested by 63 growers, San Joaquin Valley, 1949

(Average per grower)

| Item | San Joaquin Valley | Area | | | | |
|---|---|---|---|---|---|---|
| | | South | East-side | Central | West-side | North |
| No. of records | 63 | 15 | 16 | 9 | 9 | 14 |
| Operating season | | | | | | |
| Beginning date, av. | Oct.19 | Oct.19 | Oct.21 | Oct.25 | Oct.12 | Oct.15 |
| Ending date, av. | Jan. 1 | Jan. 5 | Dec.28 | Jan. 9 | Dec.27 | Dec.31 |
| Total elapsed days | 75 | 79 | 69 | 77 | 77 | 78 |
| Days operated | Day | Day | Day | Day | Day | Day |
| 1st picking | 26 | 29 | 24 | 31 | 32 | 17 |
| 2nd picking | 21 | 26 | 21 | 14 | 20 | 20 |
| Total | 47 | 55 | 45 | 45 | 52 | 37 |
| Machine-hours operated | Hour | Hour | Hour | Hour | Hour | Hour |
| 1st picking | 243 | 239 | 250 | 235 | 307 | 203 |
| 2nd picking | 164 | 175 | 177 | 81 | 172 | 184 |
| Total | 407 | 414 | 427 | 316 | 479 | 387 |
| Acres harvested | Acre | Acre | Acre | Acre | Acre | Acre |
| 1st picking | 145 | 128 | 152 | 180 | 169 | 120 |
| 2nd picking | 139 | 135 | 157 | 93 | 148 | 145 |
| Total | 284 | 263 | 309 | 273 | 317 | 265 |
| Bales harvested | Bale | Bale | Bale | Bale | Bale | Bale |
| 1st picking | 182 | 201 | 185 | 183 | 244 | 116 |
| 2nd picking | 47 | 57 | 60 | 18 | 48 | 42 |
| Total | 229 | 258 | 245 | 201 | 292 | 158 |
| Seed cotton harvested | Cwt. | Cwt. | Cwt. | Cwt. | Cwt. | Cwt. |
| 1st picking | 2482 | 2831 | 2540 | 2446 | 3253 | 1570 |
| 2nd picking | 701 | 911 | 841 | 260 | 702 | 598 |
| Total | 3183 | 3742 | 3381 | 2706 | 3955 | 2168 |

## Summary of Performance Rates

The number of acres the harvester picks depends upon the gear speed and the time stopped in the field. The harvesters studied were one-row, two-gear speed machines designed to operate at 2.00 miles per hour in first gear and 2.75 miles per hour in second.[5] On cotton in 38-inch rows, this rate would cover 0.77 acre per hour in first gear and 1.06 acres in second. Harvesters cannot maintain these rates because they must stop for turning, unloading the basket, and for servicing and adjustment. The harvesters studied picked, on the average, 0.60 acre per machine-hour in first picking, 0.85 acre in second picking. A machine-hour includes time for the stops just mentioned.

The amount of cotton a harvester will pick in a given time is directly related to yield, the amount of open seed cotton. The harvesters studied picked, on the average, 1,021 pounds of seed cotton per machine-hour in first picking, and 429 pounds in second picking.[6] One machine successfully operated in 2.7-bale first picking, and picked 3,585 pounds of seed cotton per machine-hour.

Table 2.- Average performance rates of 63 mechanical harvesters, San Joaquin Valley, 1949

| Item [1] | San Joaquin Valley | Area | | | | |
|---|---|---|---|---|---|---|
| | | South | East-side | Central | West-side | North |
| Seed cotton harvested per machine hour | Pound | Pound | Pound | Pound | Pound | Pound |
| First picking | 1,021 | 1,182 | 1,016 | 1,040 | 1,062 | 772 |
| Second picking | 429 | 521 | 475 | 322 | 408 | 584 |
| All picking | 783 | 903 | 792 | 856 | 826 | 560 |
| Bales harvested per workday | Bale | Bale | Bale | Bale | Bale | Bale |
| First picking | 7.0 | 7.0 | 7.6 | 5.8 | 7.6 | 6.9 |
| Second picking | 2.3 | 2.1 | 2.8 | 1.3 | 2.4 | 2.1 |
| All picking | 4.9 | 4.6 | 5.4 | 4.4 | 5.6 | 4.3 |

[1] Other rates, "Acres per machine-hour", and "Bales per machine-hour" are found in table 3.

Another measure of performance is the pick per working day. The harvesters picked on the average, 7.0 bales per workday in first picking and 2.3 bales in second picking. For the season they averaged 4.9 bales per day operated. The machine that operated in 2.7-bale cotton, averaged 17.2 bales a day. Variations among the sub-areas are shown in table 2.

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[5] As indicated in the 1949 Owner's Manual furnished with the harvester.

[6] Second picking was not necessarily on same acreage as first picking.

## Discussion

Many growers made maximum use of their machines during the 1949 season. Even without chemical defoliants many went ahead with machine first picking. The record large cotton crop made this necessary. Machine first picking surprised many growers because the result was more successful than expected. Growers found they could use machines in some cases even before the plants had defoliated, if leaves had wilted to a dull grey green and a good percentage of the bolls were open.[7] After mid-season, under pressure of a huge harvest, some machines actually operated beyond their effective capacity. At times they were operated when conditions were unfavorable; nights when humidity was too high, days when there was too much fog or dew. But in pressing output to the limit, growers often sacrificed grade of lint. Moreover, the rate of output was reduced when picking conditions were unfavorable.

About half the growers did not make full use of their machines, for various reasons. Some were hesitant about using machines in first picking. Some, either because their experience with machine picking has been unsatisfactory or for other reasons, still were using machines merely to supplement hand-picking. Some growers were using machines for the first time, and some bought machines after the picking season had begun. Most of these growers said they will use their machines more fully in the 1950 season.

When considering whether to convert to mechanized harvest, growers need to know how much a machine will do in a normal season. The experience of 31 growers who operated machines approximately a full season is an indication. They averaged 356 acres of picking by operating 62 working days or 520 machine-hours. These data indicate that growers can expect to operate 60 working days or 500 hours in a typical season. We can safely say a machine can harvest completely 200 acres of cotton in a season. As a rule, all of the cotton bolls would open before first-picking was finished, so perhaps no more than 150 acres would need a second-picking. If so, in total there would be 350 acres of picking, once over. These estimates appear reasonable, even though 1949 was somewhat more favorable for machine harvesting than an average season would be. Improved technology may offset any disadvantages of less favorable weather conditions.

## COST OF MACHINE PICKING

The cost of picking is one of the important factors affecting the over-all economics of harvesting cotton mechanically. This is true when considering machine picking costs as such or when comparing them with costs of hand picking. Picking costs include the total of all costs of machine picking, including overhead, but excluding consideration of field waste and grade loss. Information on picking costs was obtained by interviewing 63 growers, each of whom operated one mechanical harvester in 1949. Those interviewed were located in the five sub-areas of the San Joaquin Valley. (See figure 1.)

The three main classes of costs that concern these operators using mechanical harvesters are (a) overhead, (b) operation, and (c) labor.

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[7] Growers reported that wilting is induced by timely removal of irrigation water.

## Cost Per Bale, Per Hour, Per Acre, and Per Hundredweight of Seed Cotton

The total cost per bale was $14.65 for 229 bales harvested (Figure 2.) Over half this cost was overhead, one-third was annual operating cost, and one-fifth was labor. The harvester proper accounted for $6.19, and the tractor $1.38 out of the total overhead cost of $7.57. The machines studied harvested, on the average, slightly over one-half bale per hour and the cost per hour of operation averaged $8.25. The cost per acre averaged $11.82. The average figure of four-fifths of a bale per acre harvested is a resultant of averaging together both first and second picking. The pick per hour typically was much greater the first time over than in later pickings. The range covering the five sub-areas in total picking cost per bale was from $11.71 in West-side to $20.72 in the north. The range, omitting the northern group, was from $11.71 to $15.77 (in central). The relatively small number of bales machine-picked in the northern area largely explains its high cost per bale. The figures are 158 as compared with the average of 229 for the Valley.

The average cost of machine picking per hundredweight of seed cotton was $0.81 in first picking and $1.93 in second picking. Cost per hundredweight was higher in second picking because less seed cotton was picked per hour. Variations in cost per hundredweight among the sub-areas are summarized as follows:

| | Direct cost of machine picking per hundredweight of seed cotton | | | | | |
|---|---|---|---|---|---|---|
| | San Joaquin Valley | South | East-side | Central | West-side | North |
| First picking | $ .81 | $ .68 | $ .80 | $ .96 | $ .67 | $1.09 |
| Second picking | 1.93 | 1.54 | 1.71 | 3.13 | 1.75 | 2.60 |
| Average, all picking | $1.05 | $ .89 | $1.03 | $1.17 | $ .86 | $1.51 |

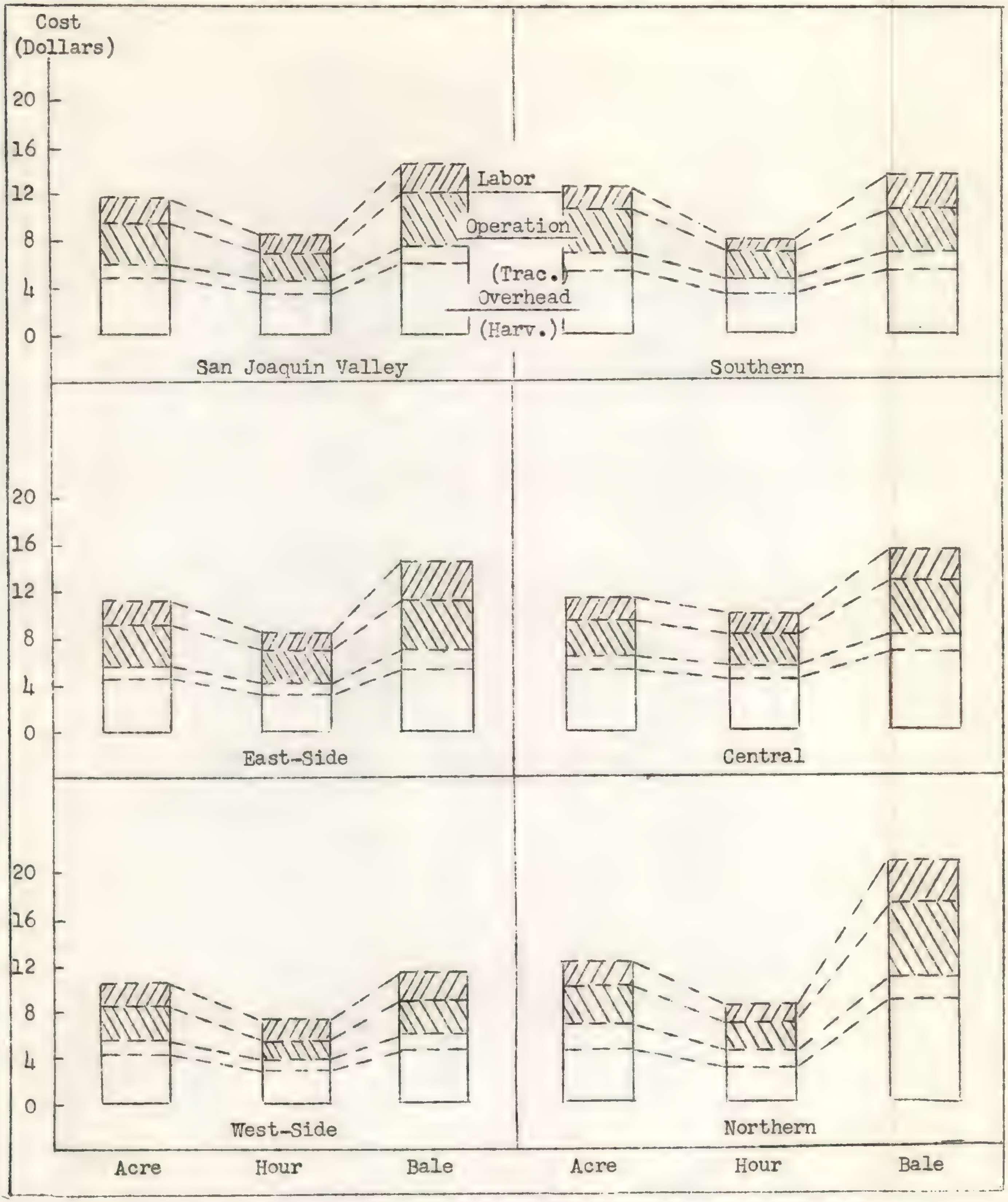
These costs are exclusive of the field waste and grade loss, reported elsewhere.

## Cost Per Machine Surveyed

Total cost of operating mechanical cotton harvesters surveyed by the growers averaged $3,355 in the San Joaquin Valley in 1949 (**Table 3.**) Overhead costs were of major importance, as they were responsible for over half of this total. Operating expenses, including materials and services plus labor, accounted for the remainder. Actually, labor was the least expensive item involved in machine picking.

The amount invested in the mechanical harvester and the tractor on which it is mounted explains the dominance of overhead cost. Depreciation and interest on investment in these machines account for the bulk of overhead. The average annual value during the assumed life of these machines was used in calculating depreciation and interest on investment. The total average annual value was $3,714 for the harvester and $1,696 for the tractor.

FIGURE 2. Costs per acre, per bale and per hour; usual investment, picking costs, and labor expense in mechanical harvesting of cotton, 1949.



Overhead cost of picker and tractor accounted for most of the total, with picking operations and labor the other major items.

Based on Table 3.

Table 3.- Usual investment, costs and labor used in mechanical harvesting of cotton by 63 San Joaquin Valley growers, 1949

| Item | San Joaquin Valley (63 Growers) | | | | Southern Area (15 Growers) | | | |
|---|---|---|---|---|---|---|---|---|
| | Season Total | Average per | | | Season Total | Average per | | |
| | | Acre | Hour | Bale | | Acre | Hour | Bale |
| Acres of picking | 284 | --- | .69 | 1.24 | 263 | --- | .64 | 1.02 |
| Machine hours | 407 | 1.43 | --- | 1.78 | 414 | 1.57 | --- | 1.60 |
| Bales harvested | 229 | .81 | .56 | --- | 258 | .98 | .62 | --- |
| | | Dollars | | | | Dollars | | |
| Investment | | | | | | | | |
| Harvester | 3,714 | 13.08 | 9.12 | 16.22 | 3,738 | 14.21 | 9.03 | 14.49 |
| Tractor | 1,696 | 5.97 | 4.17 | 7.41 | 1,620 | 6.16 | 3.91 | 6.28 |
| Total | 5,410 | 19.05 | 13.29 | 23.63 | 5,358 | 20.37 | 12.94 | 20.77 |
| Picking Costs | | | | | | | | |
| Overhead: | | | | | | | | |
| Harvester | 1,417 | 4.99 | 3.48 | 6.19 | 1,471 | 5.59 | 3.55 | 5.70 |
| Tractor | 317 | 1.12 | .78 | 1.38 | 335 | 1.27 | .81 | 1.30 |
| Total | 1,734 | 6.11 | 4.26 | 7.57 | 1,806 | 6.86 | 4.36 | 7.00 |
| Operation: | | | | | | | | |
| Harvester | 869 | 3.06 | 2.14 | 3.80 | 778 | 2.96 | 1.88 | 3.02 |
| Tractor | 147 | .52 | .36 | .64 | 156 | .59 | .38 | .60 |
| Total | 1,016 | 3.58 | 2.50 | 4.44 | 934 | 3.55 | 2.26 | 3.62 |
| Labor: | | | | | | | | |
| Operating 1/ | 506 | 1.78 | 1.24 | 2.21 | 499 | 1.90 | 1.20 | 1.93 |
| Service & repair | 84 | .30 | .21 | .37 | 65 | .25 | .16 | .25 |
| Farm shop | 8 | .03 | .02 | .03 | 11 | .04 | .03 | .04 |
| Compensation | 7 | .02 | .02 | .03 | 6 | .02 | .01 | .02 |
| Total | 605 | 2.13 | 1.49 | 2.64 | 581 | 2.21 | 1.40 | 2.24 |
| Total Costs | 3,355 | 11.82 | 8.25 | 14.65 | 3,321 | 12.62 | 8.02 | 12.86 |
| | | Man-hours | | | | Man-hours | | |
| Labor used | | | | | | | | |
| Operating | 407 | 1.43 | 1.00 | 1.78 | 414 | 1.57 | 1.00 | 1.60 |
| Other | 101 | .36 | .25 | .44 | 91 | .35 | .22 | .35 |
| Total | 508 | 1.79 | 1.25 | 2.22 | 505 | 1.92 | 1.22 | 1.95 |

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1/ Includes bonuses. The following number of growers paid bonuses averaging indicated amounts by sub-areas: South, 7 growers, $208; East-side, 2 growers, $188; Central, 2 growers, $247; West-side, 1 grower, $460; North, 1 grower, $94.

Continued

Table 3.- Usual investment, costs and labor used in mechanical harvesting of cotton by 63 San Joaquin Valley growers, 1949 - Continued

| Item | East-side Area (16 Growers) | | | | Central Area (9 Growers) | | | |
|---|---|---|---|---|---|---|---|---|
| | Season | Average per | | | Season | Average per | | |
| | Total | Acre | Hour | Bale | Total | Acre | Hour | Bale |
| Acres of picking | 309 | --- | .72 | 1.26 | 273 | --- | .86 | 1.36 |
| Machine hours | 427 | 1.38 | --- | 1.74 | 316 | 1.16 | --- | 1.57 |
| Bales harvested | 245 | .79 | .57 | --- | 201 | .74 | .64 | --- |
| Investment | | | Dollars | | | | Dollars | |
| Harvester | 3,709 | 12.00 | 8.69 | 15.14 | 3,729 | 13.66 | 11.80 | 18.55 |
| Tractor | 1,730 | 5.60 | 4.05 | 7.06 | 1,678 | 6.15 | 5.31 | 8.35 |
| Total | 5,439 | 17.60 | 12.74 | 22.20 | 5,407 | 19.81 | 17.11 | 26.90 |
| Picking Costs | | | | | | | | |
| Overhead: | | | | | | | | |
| Harvester | 1,410 | 4.56 | 3.30 | 5.75 | 1,421 | 5.21 | 4.50 | 7.07 |
| Tractor | 306 | .99 | .72 | 1.25 | 239 | .88 | .76 | 1.19 |
| Total | 1,716 | 5.55 | 4.02 | 7.00 | 1,660 | 6.09 | 5.26 | 8.26 |
| Operation: | | | | | | | | |
| Harvester | 1,005 | 3.25 | 2.35 | 4.10 | 879 | 3.22 | 2.78 | 4.37 |
| Tractor | 155 | .50 | .36 | .63 | 120 | .44 | .38 | .60 |
| Total | 1,160 | 3.75 | 2.71 | 4.73 | 999 | 3.66 | 3.16 | 4.97 |
| Labor: | | | | | | | | |
| Operating 1/ | 495 | 1.60 | 1.16 | 2.02 | 444 | 1.62 | 1.41 | 2.21 |
| Service & repair | 89 | .29 | .21 | .36 | 61 | .22 | .19 | .30 |
| Farm shop | 3 | .01 | .01 | .01 | 2/ | 2/ | 2/ | 2/ |
| Compensation | 7 | .02 | .02 | .03 | 6 | .02 | .02 | .03 |
| Total | 594 | 1.92 | 1.40 | 2.42 | 511 | 1.86 | 1.62 | 2.54 |
| Total Costs | 3,470 | 11.22 | 8.13 | 14.15 | 3,170 | 11.61 | 10.04 | 15.77 |
| Labor used | | | Man-hours | | | | Man-hours | |
| Operating | 427 | 1.38 | 1.00 | 1.74 | 316 | 1.16 | 1.00 | 1.57 |
| Other | 110 | .36 | .26 | .45 | 66 | .24 | .21 | .33 |
| Total | 537 | 1.74 | 1.26 | 2.19 | 382 | 1.40 | 1.21 | 1.90 |

---

1/ Includes bonuses. The following number of growers paid bonuses averaging indicated amounts by sub-areas: South, 7 growers, $208; East-side, 2 growers, $188; Central, 2 growers, $247; West-side, 1 grower, $460; North, 1 grower, $94.

2/ Less than one-half cent.

Continued

Table 3.- Usual investment, costs and labor used in mechanical harvesting of cotton by 63 San Joaquin Valley growers, 1949 - Continued

| Item | West-side Area (9 Growers) | | | | Northern Area (14 Growers) | | | |
|---|---|---|---|---|---|---|---|---|
| | Season | Average per | | | Season | Average per | | |
| | Total | Acre | Hour | Bale | Total | Acre | Hour | Bale |
| Acres of picking | 317 | --- | .66 | 1.08 | 265 | --- | .66 | 1.68 |
| Machine Hours | 479 | 1.51 | --- | 1.64 | 387 | 1.46 | --- | 2.45 |
| Bales harvested | 292 | .92 | .61 | --- | 158 | .60 | .40 | --- |
| Investment | | Dollars | | | | Dollars | | |
| Harvester | 3,672 | 11.58 | 7.67 | 12.58 | 3,712 | 14.01 | 9.59 | 23.49 |
| Tractor | 1,653 | 5.22 | 3.45 | 5.66 | 1,779 | 6.71 | 4.60 | 11.26 |
| Total | 5,325 | 16.80 | 11.12 | 18.24 | 5,491 | 20.72 | 14.19 | 34.75 |
| Picking Costs | | | | | | | | |
| Overhead: | | | | | | | | |
| Harvester | 1,349 | 4.26 | 2.82 | 4.62 | 1,410 | 5.32 | 3.64 | 8.92 |
| Tractor | 312 | .98 | .65 | 1.07 | 363 | 1.37 | .94 | 2.30 |
| Total | 1,661 | 5.24 | 3.47 | 5.69 | 1,773 | 6.69 | 4.58 | 11.22 |
| Operation: | | | | | | | | |
| Harvester | 815 | 2.57 | 1.70 | 2.79 | 782 | 2.95 | 2.02 | 4.95 |
| Tractor | 173 | .55 | .36 | .59 | 126 | .48 | .33 | .80 |
| Total | 988 | 3.12 | 2.06 | 3.38 | 908 | 3.43 | 2.35 | 5.75 |
| Labor: | | | | | | | | |
| Operating 1/ | 660 | 2.09 | 1.38 | 2.26 | 466 | 1.75 | 1.20 | 2.95 |
| Service & repair | 103 | .32 | .22 | .35 | 100 | .38 | .26 | .63 |
| Farm shop | 2/ | 2/ | 2/ | 2/ | 20 | .08 | .05 | .13 |
| Compensation | 9 | .03 | .02 | .03 | 6 | .02 | .02 | .04 |
| Total | 772 | 2.44 | 1.62 | 2.64 | 592 | 2.23 | 1.53 | 3.75 |
| Total Costs | 3,421 | 10.80 | 7.15 | 11.71 | 3,273 | 12.35 | 8.46 | 20.72 |
| Labor used | | | | | | | | |
| Operating | 479 | 1.51 | 1.00 | 1.64 | 387 | 1.46 | 1.00 | 2.45 |
| Other | 117 | .37 | .24 | .40 | 111 | .42 | .29 | .70 |
| Total | 596 | 1.88 | 1.24 | 2.04 | 498 | 1.88 | 1.29 | 3.15 |

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1/ Includes bonuses. The following number of growers paid bonuses averaging indicated amounts by sub-areas: South, 7 growers, $208; East-side, 2 growers, $188; Central, 2 growers, $247; West-side, 1 grower, $460; North, 1 grower, $94.

2/ Less than one-half cent.

Costs of labor used in operating the machine in the field, at $506, account for over 80 percent of the total labor expense. Service and repair labor is responsible for most of the remainder. Farm shop and cost of compensation insurance were responsible for minor amounts. Such bonuses as were paid, were averaged in with other costs for operating labor. Only thirteen of the operators paid a bonus and the total amount was of minor importance when included in the averages for the entire group.

There was a narrow range of variation in total costs of harvesting cotton mechanically among the five sub-areas studied. The central area with an average total cost of $3,170 had the lowest costs, while the East-side with a figure of $3,470 had the highest. Thus the difference was $300 (Figure 2.).

Total labor cost varied the widest among the major classes of cost in the several sub-areas. The $511 figure for the central area was just two-thirds of the figure for West-side. The widest difference in operating cost was $252, between the northern area ($908) and East-side ($1,160). The range for overhead cost was from a low of $1,660 (central) to a high of $1,806 (south). Obviously, cost of labor and cost of machine operation are closely related to the total time the machines are used. This point will be developed further in later sections.

Overhead Costs. Overhead costs, as indicated above, represented over half of the total cost for operating mechanical harvesters in the San Joaquin Valley in 1949. More than eighty percent of this total was charged against the harvester proper, with the tractor responsible for the remainder. Depreciation and interest on investment were responsible for most of the total overhead cost for both machines. About three-fourths of the total harvester overhead cost was depreciation while interest on investment accounted for another tenth of the total (Figure 3.).

Overhead costs for the tractor were handled differently than those for the harvester in two respects, (a) annual repairs were included in overhead and (b) a percentage of total overhead cost was charged to the cotton harvesting operation. This was done because, typically, the tractor used with the cotton harvester was used for other work as well. Depreciation still accounted for two-thirds of total overhead cost, however, even after including repair costs. Interest on investment accounted for nearly another 12 percent of the total for the tractor.

Original cost and average annual investment obviously are vitally influential in determining the annual costs for depreciation and interest on investment. The original cost averaged $6,459 for harvesters and $2,950 for tractors owned by the growers surveyed. Annual depreciation was calculated by (a) establishing ending value, or salvage value, (b) subtracting this value from original cost to obtain total depreciation, and (c) dividing the latter figure by estimated annual life. The total depreciation averaged $5,490 for the sixty-three harvesters studied, or an annual average of $1,112. The total depreciation for the tractors averaged $2,508 and the annual depreciation was $371.

Costs of labor used in operating the machine in the field, at $5[illegible] account for over 80 percent of the total labor expense. Service and repair labor is responsible for most of the remainder. Farm shop and cost of compensation insurance were responsible for minor amounts. Such bonuses as were paid, were averaged in with other costs for operating labor. Only thirteen of the operators paid a bonus and the total amount was of minor importance when included in the averages for the entire group.

There was a narrow range of variation in total costs of harvesting cotton mechanically among the five sub-areas studied. The central area with an average total cost of $3,17[illegible] had the lowest costs, while the East-side with a figure of $3,470 had the highest. Thus the difference was $[illegible]00 (Figure 2.).

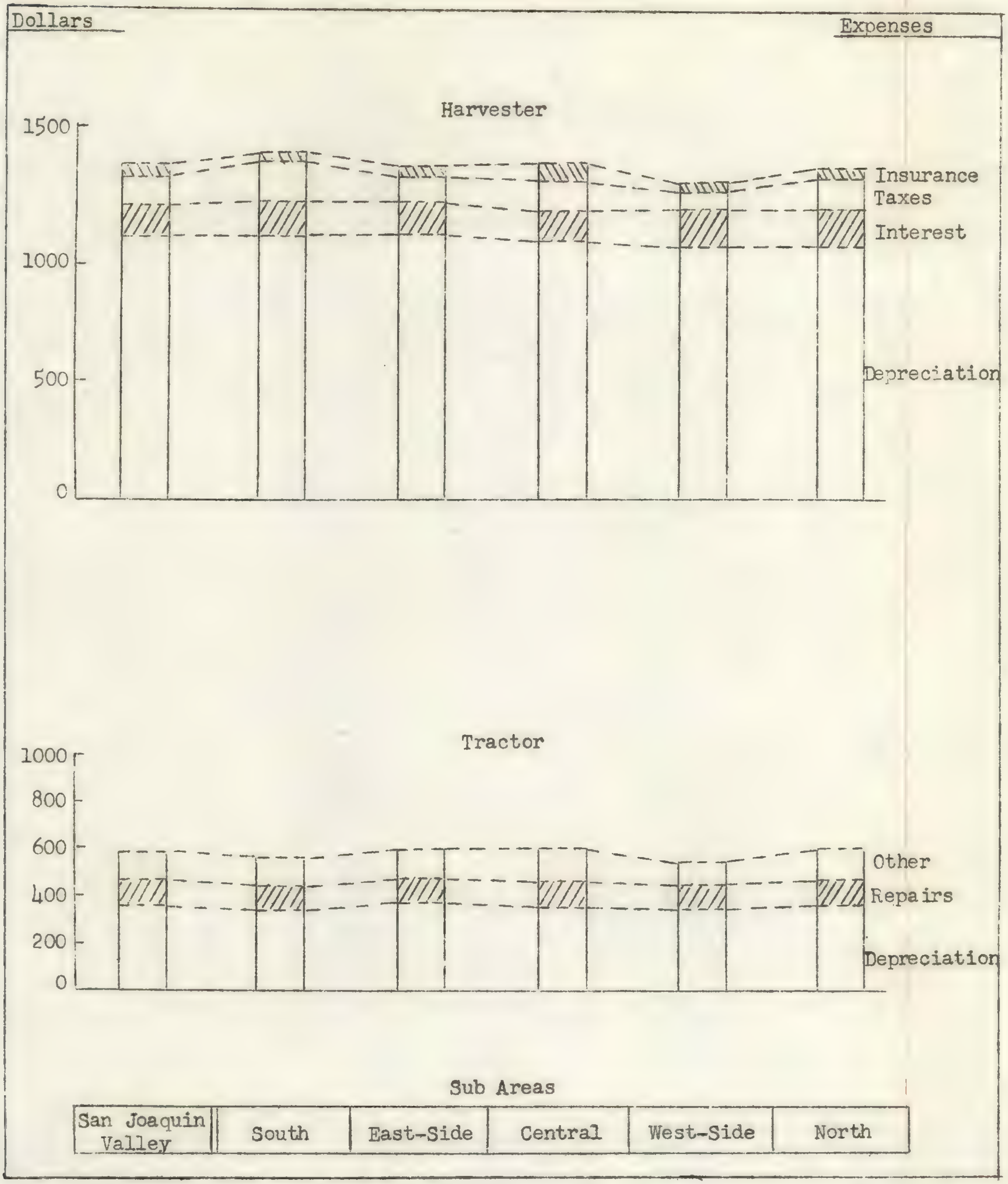
Total labor cost varied the widest among the major classes of cost in the several sub-areas. The [illegible] figure for the central area was just two-thirds of the figure for West-side. The widest difference in operating cost was $292, between the northern area ($[illegible]) and East-side ($1,[illegible]). The range for overhead cost was from a low of $1,[illegible] (central) to a high of $2,[illegible]06 (south). Obviously, cost of labor and cost of machine operation are closely related to the total time the machines are used. This point will be developed further in later sections.

Overhead Costs. Overhead costs, as indicated above, represented over half of the [illegible] for operating mechanical harvesters in the San Joaquin Valley in 1949. More than sixty percent of this total was charged against the harvester proper, with the tractor responsible for the remainder. Depreciation and interest on investment were responsible for most of the total overhead cost for both machines. About three-fourths of the total harvester overhead cost was depreciation while interest on investment accounted for another tenth of the total (Figure 3.).

Overhead costs for the tractor were handled differently than those for the harvester in two respects, (a) annual repairs were included in overhead and (b) a percentage of total overhead cost was charged to the cotton harvesting operation. This was done because, typically, the tractor used with the cotton harvester was used for other work as well. Depreciation still accounted for two-thirds of total overhead cost, however, even after including repair costs. Interest on investment accounted for nearly another 12 percent of the total for the tractor.

Original cost and average annual investment obviously are vitally influential in determining the annual costs for depreciation and interest on investment. The original cost averaged $[illegible] for harvesters and $2,95[illegible] for tractors owned by the growers surveyed. Annual depreciation was calculated by (a) establishing ending value, or salvage value, (b) subtracting this value from original cost to obtain total depreciation, and (c) dividing the latter figure by estimated annual life. The total depreciation averaged $[illegible] for the sixty-three harvesters studied, or an annual average of $1,12[illegible]. The total depreciation for the tractors averaged $2,5[illegible]8 and the annual depreciation was $[illegible].

FIGURE 3. Overhead costs; mechanical harvesters and tractors, 1949



Depreciation was the main item of overhead cost, and the harvester accounted for most of the total.

Based on Table 11.

[illegible]

[illegible]

[illegible]

|  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

[illegible]

|  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] |  |  |  |  |  |  |  |

[illegible]

|  |  |  |  |  |  |
|---|---|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

[illegible]

[illegible]

Length of life used in these calculations was five years for harvesters and seven years for tractors, except machines with very high annual use were depreciated more rapidly. The decision regarding length of life was arbitrary for the harvester in particular. The oldest machine included in the study was purchased in 1947. As this is a newly developed machine, major modifications and improvements have naturally occurred since. It is impossible, therefore, on the basis of experience to establish an average length of life but it is considered that the figures actually used are reasonable. They represent the combined judgment of experienced operators and dealers. Variations among sub-areas in overhead costs were of minor scale as might be expected in view of the newness of the mechanical harvester and the close similarity in age and operating condition of the machines studied.

Operating Expenses. The harvester accounted for $869 annual operating expense, over half of the combined total (Figure 4). Labor expense ranked in second place, representing about 40 percent of the total, with the tractor operating expense accounting for slightly less than 10 percent. The tractor expense figure is somewhat misleading inasmuch as repairs were included with overhead, as indicated previously. The largest item in harvester expenses was pre-season repair, $505 on the average, while seasonal repair was responsible for almost $200 more. The total figure, $700, represents 80 percent of operating expenses for the harvester. The figure for pre-season repair was particularly difficult to learn because a large proportion of the growers operated harvesters that were new in 1949. The pre-season repair figure is based on an average of expenses reported by those operators who had used machines for at least one season prior to 1949. Costs of mounting and dismounting the harvester in order to use the tractor for other purposes ranked third among harvester expense items. Other items were relatively unimportant in affecting total cost. Fuel necessarily accounted for most of the tractor expense (due to the procedure used in analyzing repairs).

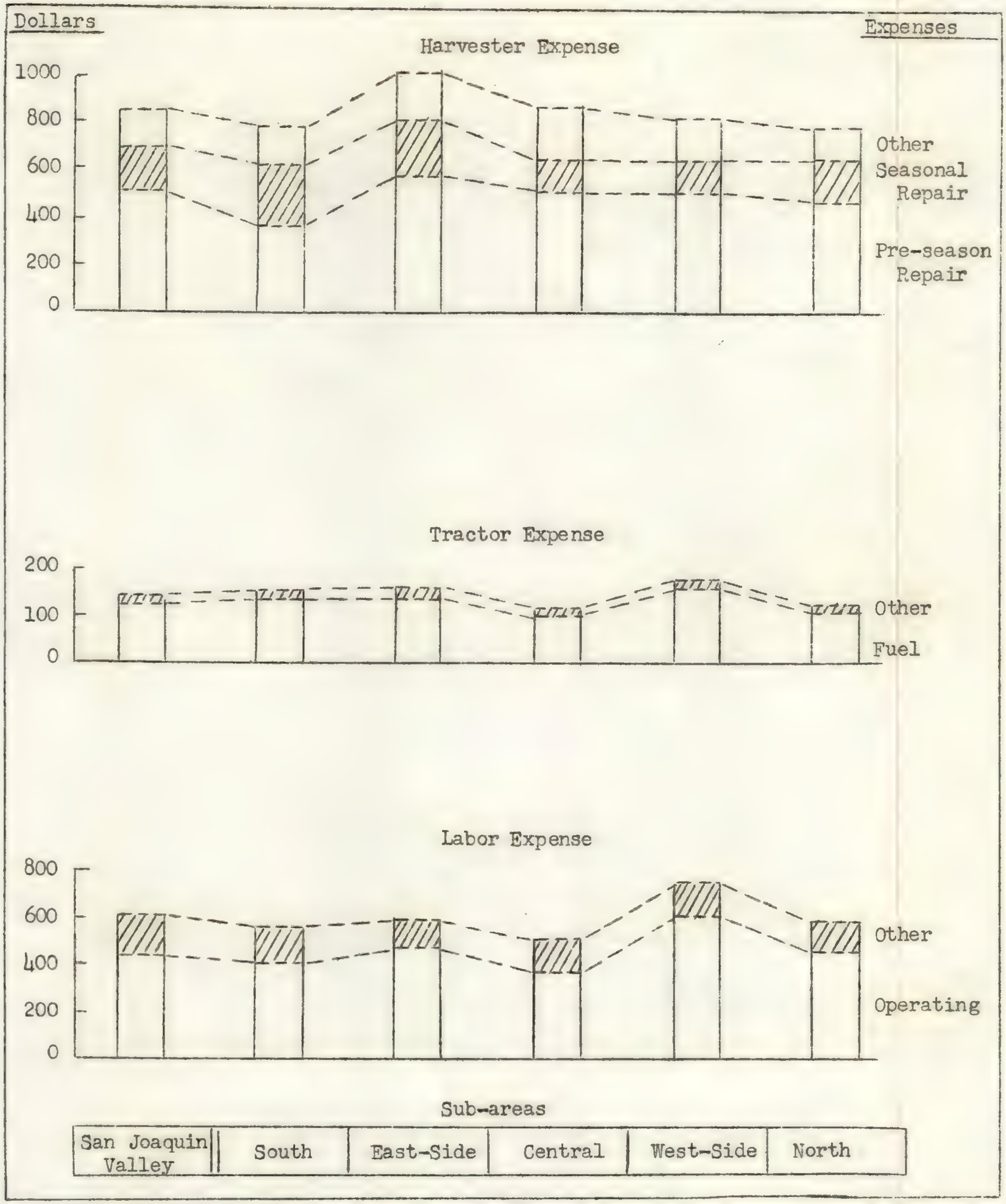
The actual cost of field operation was responsible for most of the labor expense, with service and repair costs ranking second (Figure 4). A few operators paid bonuses which were considerable items of cost for those reporting. The average amount of bonus paid, however, for all operators interviewed amounted to only $46. A relatively large proportion of the repairs on the harvesters were made in dealers' shops or by their repairman. That explains why most of the farm labor cost is for operating the harvesters. It was noted previously that pre-season plus seasonal repair costs accounted for 80 percent of total operations expense.

The range in the year's operating expense for the harvesters was from a low of $778 in the southern area to a high of $1,005 on the East-side. It was more common to pay a bonus to laborers in the southern area than in any other area. Almost half of the operators there paid such a bonus, averaging $208, and these operators represented over half of all paying a bonus in the entire Valley area studied.

## Materials and Labor Used

Spindle oil was the material used in largest volume by the mechanical pickers. Typically an initial purchase of wetting agent was made, but no more was bought after this had been used. Some operators reported that they had used

FIGURE 4. Usual operating expenses; machanical harvesters, tractors and labor, 1949.



Major expense items were pre-season repair on the harvester, operating labor and tractor fuel.

Based on Table 10.

successfully one of the popular brands of detergents instead of the special wetting agent. Fuel and oil, of course, were the principal materials required for tractor operation. An average total of 809 gallons of fuel was used by the 63 growers reporting. The labor used was mostly for operating the mechanical picker in the field. Of the total 517 man-hours the average indicated 407 used in field operations, and another 75 in servicing and minor field repairs. This labor reported does not include labor used to operate trailers or trucks to haul the seed cotton to the gin. Only a few operators indicated that added labor was used to load the trailers or to tramp the cotton; this labor was not included in the report.

## Discussion

The cost per bale for machine-harvesting cotton averaged $14.65 according to 63 growers furnishing data for the 1949 season. This cost compares with approximately $45 for hand picking.[8]

Two facts stand out regarding operating costs; (a) the dollar investment in the harvester and tractor makes high overhead costs inevitable because of depreciation and interest on investment, and (b) pre-season and seasonal repair costs for the harvester dominate operating costs. The first point largely explains how important it is to make full use of the mechanical cotton harvester. The impression was gained during interviews that added experience in using and servicing the harvester will help reduce the costs of repairs. It is pertinent that many machines were delivered in 1949, and that many operators gained their first experience that year. In some instances the operator had no specific training before taking the machine to the field. Further experience and definite pre-season training for operators undoubtedly will help cut the costs.

The amount of cotton harvested is highly influential in governing cost per bale for machine picking. It was largely the smaller number of bales harvested that caused cost per bale to be high in the northern sub-area. The study indicated that it is possible for one machine to harvest considerably more cotton than usually was reported. West-side growers, for example, reported 292 bales harvested--64 bales or 28 percent more than the average. Factors responsible for reducing the average number of bales harvested per machine in 1949 have been discussed previously. This problem of incomplete use of the mechanical harvester can be corrected by earlier planning and by using specific correctives for the reasons associated with limited use.

Added years of use beyond the five and seven years assumed for harvesters and tractors would operate to reduce harvesting costs. Longer life would be accompanied by lower annual cost of depreciation and interest, already indicated to be dominant in harvesting costs. Certainly, cost of obsolescence should be of diminishing importance now that mechanical picking is established. It is likely, also, that length of effective life will be extended by more effective operations and maintenance.

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[8] Hand picking cost was estimated by assuming 13.5 hundredweight of seed cotton for a bale of lint and multiplying by 1949 picking cost. The latter figure averaged $3.33 for first and second hand picking according to the growers reporting.

[illegible] labor was used instead of the [illegible] or to clean the cotton, this labor was not included in the records.

[illegible]

The cost per bale for machine-harvesting cotton averaged $4.86 according to growers [illegible] for the [illegible]. This cost compares with approximately $[illegible] for hand picking.[illegible]

The [illegible] harvesting [illegible]: (1) the dollar investment in the [illegible] because of [illegible] on investment, and (2) [illegible] and seasonal repair costs. [illegible] The first point largely [illegible] cotton [illegible] interviews that [illegible] experience in [illegible] and [illegible]. It is pertinent [illegible] delivered in [illegible] gained their first experience that year. In some instances the operator had no specific [illegible] the machine to the field. Further experience and definite [illegible] will help cut the costs.

The amount of cotton harvested is highly influential in governing cost per [illegible]. It was [illegible] number of bales harvested [illegible] that [illegible] per bale [illegible] high [illegible]. The [illegible] indicates that it is possible for one machine to harvest considerably more cotton [illegible] percent more than the average. Factors responsible [illegible] number of bales harvested per machine in 1949 have been [illegible]. [illegible] of the mechanical harvester [illegible] and by taking specific corrective [illegible] the [illegible].

[illegible] the five and seven years assumed for harvesters and [illegible]. Longer life would [illegible] lower annual cost of [illegible] and interest, already indicated [illegible] costs. [illegible] obsolescence should [illegible] mechanical picking is established. It is likely [illegible] length of effective life will be extended by more effective [illegible].

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[illegible] The latter figure [illegible] according to the growers' [illegible].

Cost of mechanical harvest in light picking is of economic importance, especially in very late, second picking. Growers have questioned, for example, whether it paid them to operate a mechanical harvester for the second picking in 1/10-bale cotton, a pick of but 150 pounds of seed cotton per acre. Costs per hundredweight of seed cotton were calculated for picks ranging from 50 pounds to 350 pounds per acre (Table 4). Costs first were calculated using the total cost (including overhead) of $9.70 per acre of second picking, as found in the study.

A practical economic question facing the grower is how much seed cotton per acre must he get to afford machine picking. For a pick of 150 pounds per acre, the mechanical harvesting cost is $6.47 per hundredweight. With lint at 20 cents per pound, and cottonseed at $45 per ton, 100 pounds of seed cotton is worth about $7.70 ($8.40, less $.70 ginning costs). Under these conditions it is economically feasible to employ mechanical harvest, but it would be more economical to employ hand pickers at any charges under $6.47 per hundredweight. When the pick is 250 pounds per acre, the mechanical harvesting cost is $3.88 per hundredweight, which was about the going rate of hand second picking in 1949. In other words, machine picking is more economical than hand picking when the pick is 250 pounds or more per acre. When the pick is less, hand picking is cheaper.

Some may maintain that direct picking costs (excluding overhead and, of course, field waste and grade loss) should be used for these calculations. They would say that overhead costs should be wholly charged to earlier picking, as though the harvester were not to be used for late season scrapping operations. Accordingly, costs also were calculated using the direct cost (excluding overhead) of $4.69 per acre in second picking, as found in the study. Direct operating costs were $3.13 per hundredweight, when the pick was 150 pounds of seed cotton per acre. On the basis of direct costs only, it is economically feasible to operate a mechanical harvester where the second pick is but 150 pounds per acre.

Table 4.- Total and direct costs of machine picking per hundredweight of seed cotton, at various picks, per acre

| Pick, in pounds of seed cotton per acre | Machine picking cost per hundredweight of seed cotton | |
|---|---|---|
| | Total Costs | Direct Costs |
| | Dollar | Dollar |
| 50 | 19.40 | 9.38 |
| 100 | 9.70 | 4.69 |
| 150 | 6.47 | 3.13 |
| 200 | 4.85 | 2.34 |
| 250 | 3.88 | 1.88 |
| 300 | 3.23 | 1.56 |
| 350 | 2.77 | 1.34 |

# EFFECT OF MACHINE PICKING ON GRADES OF LINT COTTON

The economic advantages of machine picking would be great if the only fact considered were the costs of machine versus hand picking. But relative grades of lint and field waste are also important. Field waste is discussed in a later section of this report. If a mechanical harvester produces lower grades of lint cotton than hand picking would, the value of the harvested crop will be lower than if it were hand-picked. Any reduction in returns from the crop, obviously, is a part of the economic cost of machine harvesting. Total economic cost of harvesting, therefore, includes total picking costs, including overhead, plus the value of field waste and the value of grade loss to the extent they exceed comparable values for hand picking.

## How Machine Picking Can Affect Grades of Cotton

Cotton is graded according to trash (foreign matter) content, color, and preparation. High grade lint has little trash, is white in color, and has "normal" preparation. Kind as well as amount of trash is considered. Thus, if the trash consists of grass particles, the sample is further reduced one or more grades. Color is described by the terms white (or extra white), spotted, tinged, yellow-stained, or gray. Preparation refers to the arrangement or appearance of fibres in the sample; one showing "rough" preparation may be further reduced one or more grades.

The grades of cotton lint are the result of the quality of the standing cotton, of the picking, and of the ginning. Immature or weathered standing cotton will not result in lint of good grades — however excellent the picking and ginning. In picking (either hand or machine), some trash is collected along with the seed cotton, and discoloration may be introduced (especially green leaf stain). Gins are equipped to remove a substantial amount of the trash in picked seed cotton, as well as to separate the lint from the seed but they are not equipped to remove discoloration.

Mechanical cotton harvesters can affect the grades of the lint by affecting the amount of trash or discoloration introduced into the seed cotton during picking and by the degree of twisting or tangling of the lint. The various ways in which machines may reduce grades of the lint (below the grades that would have been attained by hand picking) may be summarized as by:

(1) Introducing excessive discoloration from green plant leaves early in the season,

(2) Introducing more trash from the dead cotton plants late in the season,

(3) Gathering more foreign matter from weeds or grass in the field,

(4) Adding excess moisture (in spindle moistening) to the lint (and trash) making trash removal by gin cleaners more difficult, and inducing graying or mildew if ginning is delayed,

(5) Twisting or tangling the lint on the spindles thus increasing the difficulty of normal gin preparation,

(6) Discoloring the lint with oil or grease from the machine.

On the other hand, mechanical harvesters may improve the grades of the lint by passing over "hard-to-pick" immature bolls late in the season, by adding less trash than careless hand pickers, and by "timeliness" of harvesting the crop. The grade of the crop may average higher if harvested earlier by machine than if harvested later by slower hand picking.

## How Measure Effect of Machine Picking on Grades of Lint Cotton

The present study was not designed to measure separately the effect of each influence of machine picking on the grades of the lint. Instead, it was designed to measure the net or combined effects of all factors entering into machine picking.

The effect of machine picking on grades is shown in this case by comparing the grades of machine-picked bales with the grades of hand-picked bales.[9] For the comparison to be valid it is essential that cotton picked by both methods be grown and ginned under similar conditions. Bales of machine-picked and bales of hand-picked from the same gins were used as the bulk of the evidence in this study.[10] Such choice of data insured comparable ginning conditions. It was practicable to collect data exclusively from fields where both machine and hand picking was done because it is uncommon for growers to use both methods in the same field. However, data from the same gins, should represent fairly well common growing conditions (weather, soil and weed conditions) and harvesting conditions (especially weather). Almost all cotton going through one of these gins is from the immediate neighborhood, and is ginned within a few days after the picking. Thus, most of the differences found in grades would almost surely directly reflect variation in the harvesting method rather than differences in the standing cotton or in the ginning.

Three suitable devices are available for comparing grades, (1) the distribution of grades, (2) the average grade-index, and (3) the average government loan value. Number 1 is a simple array of the number of bales in each grade. Number 2, the grade-index, is a device for combining different grades into one numerical measure. The scale of index numbers used by the Production and Marketing Administration in its reports on cotton quality was used for this purpose. In this scale, Middling White cotton is 100, Strict Low Middling is 94, etc. (see Table 16 for the index numbers used). Loan values for bales of various grades were computed from Cotton Bulletin 1, and amendments, issued by the Commodity Credit Corporation.

Grades at 35 gins in the San Joaquin Valley, each gin having at least 500 bales of machine-picked cotton, were analyzed. Altogether these gins reported 62,623 machine-picked bales and 237,811 hand-picked bales in the 1949-50 ginning season (1949 crop). These data are summarized by (five) subareas in the Valley to show geographical variations. (The number of machine and hand bales reported in each area are shown in Table 13.) Seasonal average

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[9] All grades analyzed in this section and throughout the report were those assigned in the U.S.D.A. Classing Office, Bakersfield, California.

[10] The exception was data given by the growers who were interviewed, who were so scattered that seldom more than one or two were served by the same gin in each area.

comparisons are not meaningful at a gin if machine picking is concentrated in one part of the season and hand picking at some other period. The reason is that the cotton is usually of lower grades toward the end of the season -- whatever the method of picking. However, these data are useful in showing the over-all results of machine picking in the 1949 season.

At eight gins, comparisons of grades were made, week, week-by-week, throughout the 1949 season. The data used include all the machine- and hand-picked bales ginned the same two consecutive days in each week during an 18-week period, 11/ a total of 5,431 machine bales and 17,524 hand bales. The purpose of this phase of the study was to see whether machine picking affected grades more in one part of the season than another. Some people have maintained that grades of machine-picked cotton compare more favorably with grades from the hand-picked late in the season.

Grades of cotton in the bales of both machine-picked and hand-picked, from the farms of the 63 growers interviewed, also were analyzed. Both season-average and week-by-week comparisons were made.

## Summary of Grades of Machine-Picked Cotton With Comparisons

Considering the over-all average at the 35 gins in the valley, we found that more than 90 percent of both machine-picked and hand-picked bales graded white or extra white (Figure 5 and Table 5). Of the bales of machine-picked 4.5 percent were spotted, 4.2 percent were gray and 0.3 percent were "below grade." 12/ Of the bales of hand-picked, 4.1 percent were spotted, 0.1 percent were tinged, 3.5 percent were gray and 0.2 percent were below grade. Thus bales of machine-picked included a slightly higher percentage of off-color bales. (For brevity in the remainder of this report, the term "off-color" is used to include "spotted, tinged, and gray.")

Among the whites, bales of machine-picked were concentrated (44 percent) in the grade Strict Low Middling, whereas the bales of hand-picked were concentrated (62.5 percent) in the grades of Middling or better (Figure 5 and Table 5). Of the machine bales 20 percent were Middling or better and 25 percent were Low Middling or lower. The bales of hand-picked included 22 percent Strict Low Middling and only 8 percent Low Middling or lower. This same pattern, with minor variations (to be discussed later) was repeated in each of the five sub-areas of the valley. In terms of grade-index, which is a numerical average of grades, the machine-picked bales had an average index of 91.8, whereas hand-picked bales averaged 97.4. Thus, the machine-picked cotton averaged between Strict Low Middling and Low Middling, whereas hand cotton averaged between Middling and Strict Low Middling. The difference in grade-index of 5.6 was slightly less than one full grade. Bales of machine-picked had an average loan value of $132.52 per bale and bales of hand-picked averaged

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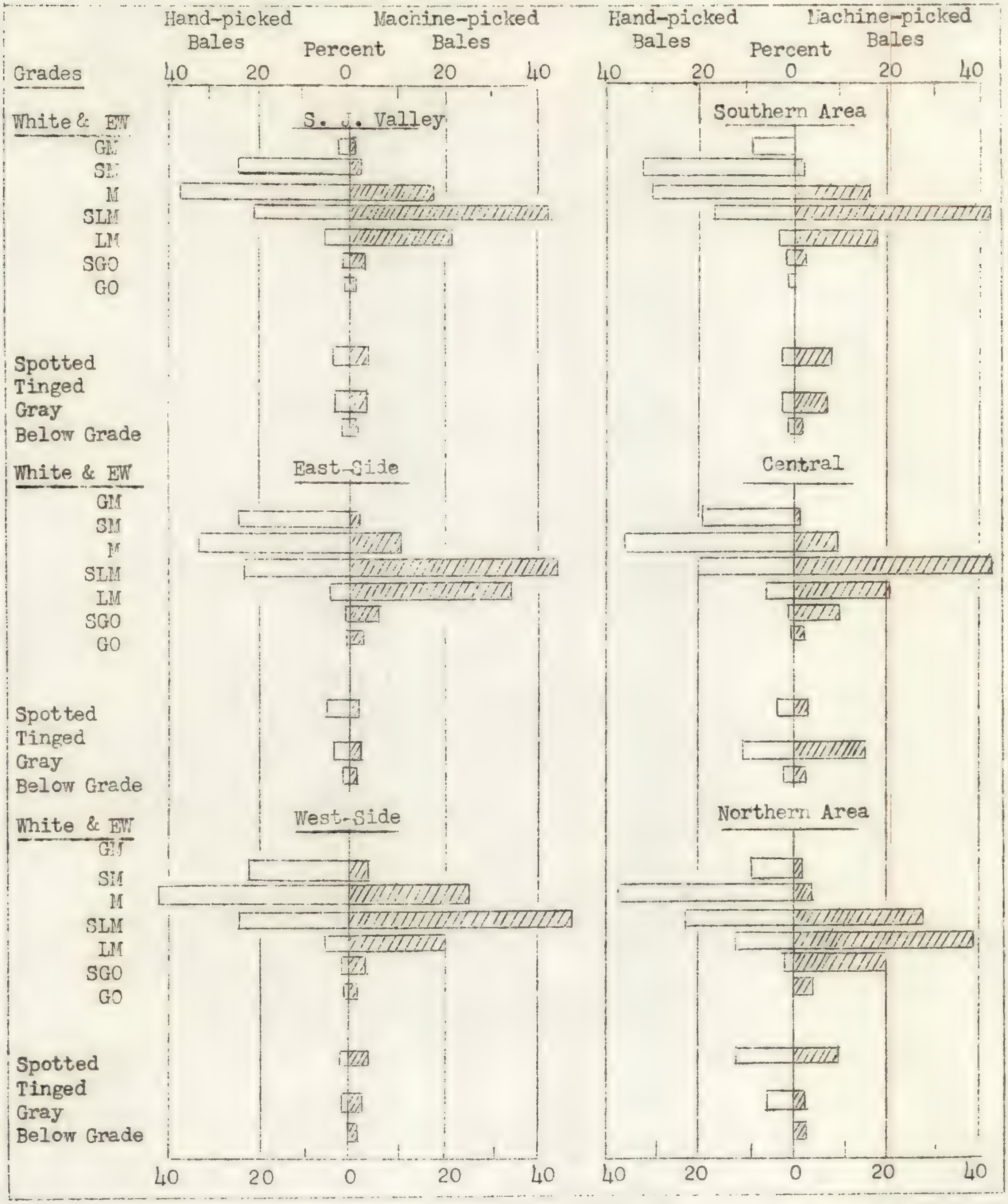
11/ Wednesday and Thursday were used, though any other two days would have done as well.

12/ Below Grade includes grades below those recognized by the U.S.D.A. Classing Office. It does not include all the grassy bales.

FIGURE 5. Machine- and hand-picked cotton; distribution at 35 gins in the San Joaquin Valley, 1949



Machine-picked bales tended to concentrate in Strict Low Middling White and hand-picked in Middling White grade. Machine-picked cotton averaged slightly less than one full grade below hand-picked cotton.

Based on Table 14.

Table 5.- Distribution of bales of machine-picked and hand-picked cotton at 35 gins, San Joaquin Valley, 1949 crop

| Grade | San Joaquin Valley | Sub-Areas | | | | |
|---|---|---|---|---|---|---|
| | | South | East-side | Central | West-side | North |
| | pct. | pct. | pct. | pct. | pct | pct. |
| | | | | Machine-Picked Bales | | |
| White and Ex. White | | | | | | |
| Middling & higher | 20.9 | 21.7 | 10.9 | 10.0 | 28.1 | 3.3 |
| Strict Low Middling | 43.8 | 42.4 | 43.9 | 43.7 | 46.3 | 27.2 |
| Low Middling& lower | 26.3 | 20.1 | 41.6 | 29.7 | 20.0 | 59.7 |
| Total | 91.0 | 84.2 | 96.4 | 83.4 | 94.4 | 90.2 |
| Spotted,tinged,gray & below grade | | | | | | |
| Middling & higher | 6.2 | 12.3 | 2.0 | 11.4 | 3.6 | 2.8 |
| Strict Low Middling | 2.2 | 2.7 | 1.0 | 5.2 | 1.5 | 5.7 |
| Low Middling & lower | .6 | .8 | .6 | --- | .5 | 1.3 |
| Total | 9.0 | 15.8 | 3.6 | 16.6 | 5.6 | 9.8 |
| Total machine-picked | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| | | | | Hand-Picked Bales | | |
| White & Extra White | | | | | | |
| Middling & higher | 62.5 | 71.0 | 59.3 | 55.8 | 64.7 | 47.0 |
| Strict Low Middling | 21.9 | 17.1 | 23.3 | 20.0 | 24.6 | 19.4 |
| Low Middling & lower | 7.7 | 5.4 | 8.0 | 9.8 | 6.9 | 14.7 |
| Total | 92.1 | 93.5 | 90.6 | 85.6 | 96.2 | 81.1 |
| Spotted,tinged,gray & below grade | | | | | | |
| Middling & higher | 6.3 | 5.6 | 7.7 | 11.3 | 3.0 | 13.8 |
| Strict Low Middling | 1.0 | .3 | 1.1 | 2.2 | .6 | 3.5 |
| Low Middling & lower | .6 | .6 | .6 | .9 | .2 | 1.6 |
| Total | 7.9 | 6.5 | 9.4 | 14.4 | 3.8 | 18.9 |
| Total hand-picked | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Table 6.- Average grade-index and loan value of bales of machine-picked and hand-picked cotton at 35 gins in San Joaquin Valley, 1949 crop

| Picking method | San Joaquin Valley | Areas | | | | |
|---|---|---|---|---|---|---|
| | | South | East-side | Central | West-side | North |
| | | Grade - Index | | | | |
| Hand-picked | 97.4 | 98.9 | 97.2 | 95.4 | 97.7 | 94.4 |
| Machine-picked | 91.8 | 92.4 | 89.6 | 89.1 | 93.3 | 85.8 |
| Difference[1] | -5.6 | -6.5 | -7.6 | -6.3 | -4.4 | -8.6 |
| | | Loan Value (dollars per bale) | | | | |
| Hand-picked | 142.84 | 144.79 | 142.39 | 139.65 | 143.96 | 136.95 |
| Machine-picked | 132.52 | 133.94 | 127.67 | 127.97 | 135.90 | 117.20 |
| Difference[1] | -10.32 | -10.85 | -14.72 | -11.68 | -8.06 | -19.75 |

[1] Minus sign indicates machine picked below hand picked.

$142.84, a difference of $10.32 a bale.[13]

The Southern Area. Bales of machine-picked averaged higher in grade in the southern area than in other sub-areas, except the West-side. Of 16,721 machine bales, 22 percent graded Middling White or better, 42 percent were Strict Low Middling and 20 percent were Low Middling or below. In comparison, 71 percent of the 50,329 bales of hand-picked were Middling White or better, 17 percent were Strict Low Middling and only 5 percent were Low Middling or lower. A relatively high percent (16%) of the bales of machine-picked were off-colored. The average grade-index of machine bales was 92.4 compared to 98.9 for hand bales. The average loan value of machine bales was $133.94 and of hand bales $144.79, a difference of $10.85 per bale. The variation among gins is indicated by the range in differences of machine versus hand grade-indexes. The range was from 3.6 to 8.9. The range in machine versus hand difference in loan value was from $6.16 to $13.26.

The East-Side Area. Bales of machine-picked on the East-side averaged higher in grade than in the northern area but lower than on the West-side. Only 11 percent of the 11,421 machine bales graded Middling White or better, 44 percent graded Strict Low Middling and 42 percent were Low Middling or lower. Only 4 percent were off-color bales, a smaller proportion than in any other sub-area. In comparison, the 68,203 hand-picked bales averaged 59 percent Middling White or better, 23 percent Strict Low Middling and 8 percent Low Middling or lower. Hand-picked bales ran 9 percent off-color. The average grade-index of machine bales was 89.6 compared to 97.2 in the case of hand bales, a difference of 7.6. Loan value of machine bales averaged $14.72 below hand bales. Variation among the 9 East-side gins is indicated by differences in grade-index (hand versus machine bales) ranging from 4.8 to 9.0 and differences in average loan value ranging from $7.77 to $18.17 per bale.

The West-Side Area. Grades of machine-picked cotton on the West-side were not only higher than in any other sub-area but they were more nearly equal to the grades for hand-picked. At the 12 West-side gins, 28 percent of the 27,332 machine bales graded Middling White or better (compared to the Valley average of 20 percent) 46 percent were Strict Low and 20 percent were Low Middling or lower. Of the West-side bales of hand-picked, two-thirds (65 percent) were Middling White or better, a fourth (25 percent) were Strict Low and only 7 percent were Low Middling or lower. This sub-area had relatively fewer off-colored machine-picked bales than the Valley average. The average grade-index of West-side machine bales was 93.3 compared to 97.7 for hand-picked. The difference of 4.4 was equivalent to about two-thirds of one full grade, hand over machine. Average loan value of machine-picked bales was $135.90, and of hand-picked bales $143.96, a difference of $8.06. There was, however, considerable variation between gins on the West-side. For example, the difference in grade-index (hand versus machine bales) ranged from 1.2 to 7.1, and the difference in loan value ranged from $1.47 to $13.34 per bale.

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13/ In estimating loan values it was assumed that all bales were 1 1/16-inch staple length, because actual staples were not reported in these data. A very large proportion of valley and area bales are 1 1/16-inch, so the results are not impaired by our assumption. As yet, there is no evidence whatever that machine picking has any effect on staple length.

The Northern Area. In the northern sub-area, machine-picked bales were not only lower in grade than in any other sub-area, but the difference between them and hand-picked bales was wider than elsewhere in the Valley. At the four northern gins, only 3 percent of the 2,636 machine bales graded Middling White or better, 27 percent graded Strict Low Middling White and 60 percent were Low Middling or below. In comparison, 47 percent of the 19,655 hand-picked bales graded Middling White or better. Northern gins had about the same proportion (9 percent) of off-color, machine-picked bales but more than twice as many (19 percent) off-color hand bales as the Valley average. The average grade-index of machine bales was 85.8 and of hand bales 94.4 at northern gins. The average loan value of the machine bales was $117.20 and of hand bales $136.95, a difference of $19.75 per bale. Among the four gins reporting, the difference in machine and hand grade-indexes ranged from -5.4 to -11.8, the difference in loan value from $-10.97 to $-28.25 per bale.

The Central Area. Machine-picked cotton in this area compares closely with the East-side in percent of Middling White or better and in percent of Strict Low Middling bales. But it had a relatively high percent (17 percent) of off-color bales, a situation similar to the northern area. The central area was similar to the East-side in the grades of hand-picked cotton. The average grade-index of machine bales was 89.1 and of hand bales, 95.4. Machine-picked bales averaged $11.68 lower in loan value than hand-picked bales.

## Seasonal Trends in Grades of Machine and Hand-picked Cotton

Growers and the cotton industry are familiar with the downward trend in grades of cotton during the harvest season. This seasonal decline is largely attributed to "weathering" and an increasing trash content. These factors are particularly evident in second-pick cotton. After mid-November occasional rains and fog contribute to staining, spotting and graying. These problems usually become aggravated as the season advances. Late season, second picking cotton usually has a higher trash content because, as there is less seed cotton to pick, the ratio of trash to seed cotton will be higher than in the first picking.

The data already presented indicated that season-average grades of machine-picked cotton were lower than the grades of hand-picked. It is of interest to see whether the grades of the machine-picked followed the same downward trend as the grades of hand-picked. Growers and others have said that "machine grades" compared more favorably with "hand grades" late in the season. Some said machine grades at that time equaled or exceeded hand grades from equal standing cotton. Weekly grade-indexes are available for each method of picking at eight gins for the 1949 season. (Figure 6 and Table 15.) These data are useful in studying trends of grades in either machine or hand cotton over the season, and in comparing the grades of machine and hand-picked cotton at various stages of the season.

A study of the data in Figure 6 and Table 15, leads to the following general conclusions and comments.

1. Grades of hand-picked cotton at all gins averaged Middling White or better until the first week in November. During this period the grades of the hand-picked had a slight downward trend.

Northern area. In the northern sub-areas, [illegible] kept half or more [illegible] than in any other sub-area, [illegible] difference between [illegible] was wider than elsewhere [illegible]. At the [illegible] a typical holding [illegible] per cent [illegible] operations ([illegible] percent) of all-colored, [illegible] but [illegible] twice as many ([illegible] percent) [illegible] in the valley average [illegible] a difference of 13.3 per cent. Among the four sub-areas remaining, the difference in [illegible] ranged from [illegible] to [illegible], the difference in form [illegible] from [illegible] to [illegible] per cent.

The Central Area. [illegible] in this area [illegible] roughly [illegible] percent of [illegible] holdings [illegible] ([illegible] percent) of all-colored [illegible] similar to the [illegible] area [illegible] similar to the [illegible] values [illegible] holdings [illegible] in [illegible] value [illegible].

[illegible]

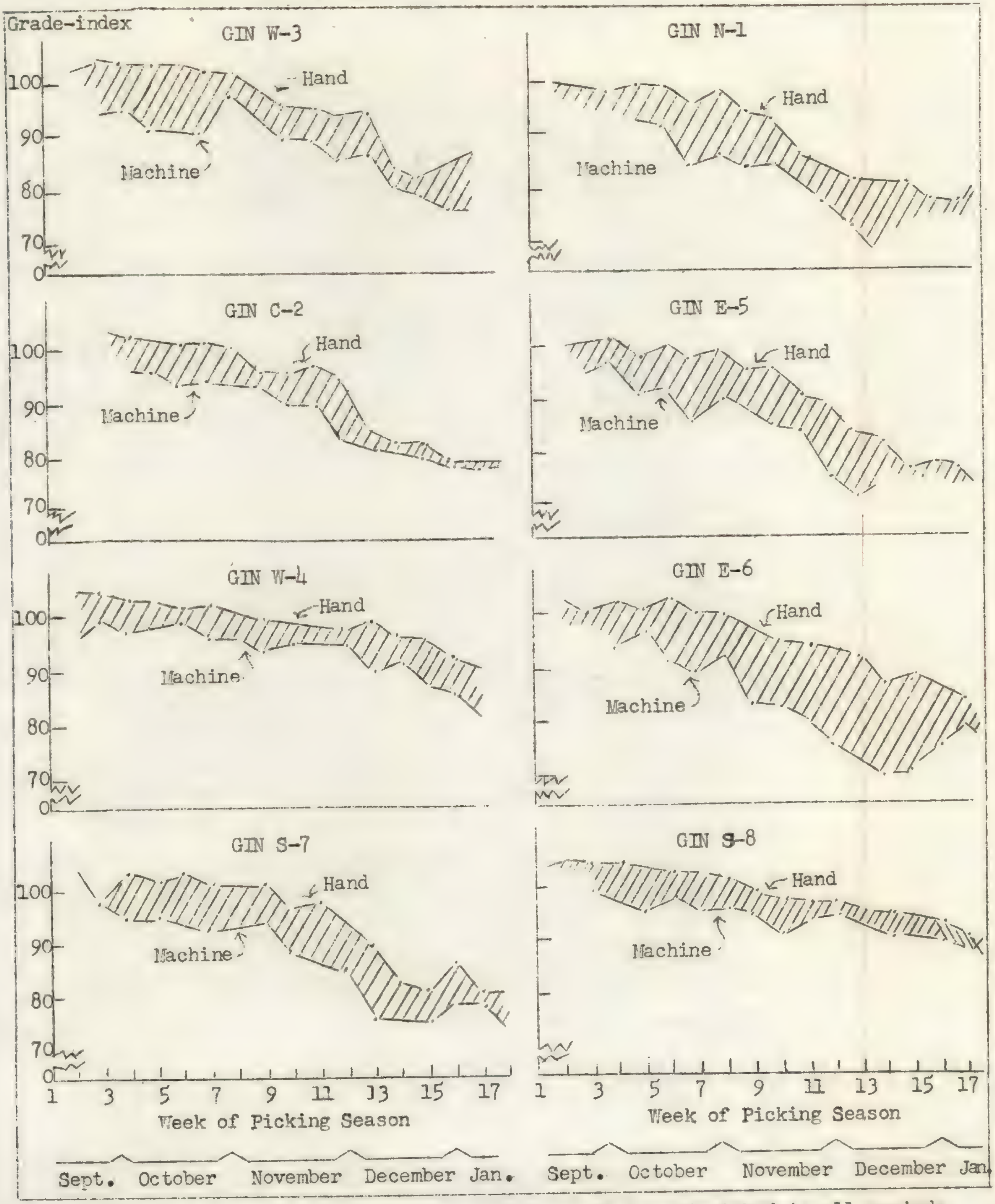
Changes on the cotton [illegible] with the [illegible] trend in [illegible] of cotton [illegible] attributed to "[illegible]" and [illegible]. These factors [illegible] and [illegible] sales and [illegible] cotton [illegible].

The [illegible] of [illegible] the [illegible] of [illegible] cotton [illegible] and [illegible].

A study of the data in Figure 6 and Table [illegible], leads to the following general conclusions [illegible]:

1. Number of [illegible] cotton [illegible] holding white or [illegible] the [illegible] period the [illegible] of [illegible].

FIGURE 6. Weekly grade-indexes of machine-picked and hand-picked cotton at eight selected San Joaquin Valley gins, 1949 crop, seasonal trends



Grades from the machined cotton averaged lower than hand-picked in all periods of the season. Grades for both declined throughout with some tendency for the spread to narrow.

Based on Table 15.

2. After November 1, grades of hand-picked cotton declined more rapidly at gins in some areas than in others. Grades declined more at the northern gin (N-1), one West-side gin (W-3), one East-side gin (E-6), and one southern gin (S-7).

3. Grades of hand-picked show less week-to-week variation than grades of machine-picked; this apparently was true at all gins.

4. Grades of machine-picked generally followed the same downward trend as grades of hand-picked, but there was considerable variation among gins. "Machine grades" definitely improved in the first week of November over the grades of the last week in October, at seven out of eight gins. A heavy frost had defoliated the cotton so conditions for machine picking were much improved.

5. Machine-picked grades on the average definitely did not equal hand-picked grades at any time during the 1949 season. They were more nearly equal at one West-side gin (W-4) and one southern gin (S-8).

6. Some tendency toward smaller differences between the grades of machine and hand cotton appeared near the end of the season, but this tendency was not so pronounced as some had believed to be true.

7. The pattern of differences in grades of machine versus hand cotton varied widely among gins. At one West-side gin (W-4) the spread between them was uniformly about 5 grade-index points throughout the season. At the other West-side gin (W-3) the spread was much wider until the last of October, after which it was similar to gin W-4. At one East-side gin (E-6) the spread in grades widened between machine and hand-picked cotton until the 15th week of the season, and it narrowed during the last three weeks.

## Grades of Machine Versus Hand-Picked Cotton For Interviewed Growers

Information on grades of cotton of the growers who were interviewed is valuable chiefly to demonstrate (though not to measure accurately) the variation among growers in results from machine picking. These data were not entirely suitable for comparing results from machine and hand picking in the Valley or in sub-areas. The interviewed growers were so scattered that seldom more than one or two were in the same neighborhood or served by the same gin. Again, growers seldom used both machines and hand pickers in the same field, and many did not use both methods during the same period of the harvest season. However, the data do show some interesting variations as among growers.

Some growers had high grades of machine-picked cotton and others had low grades in all five sub-areas of the Valley (Table 7). The grower with the highest average grade-index of machine-picked cotton was in the southern area. His average of 98.8 compares with the highest, 98.2, among interviewed growers on the West-side, 94.7 in the northern area, 94.1 on the East-side and 93.6 in the central area. The grower with the lowest season-average machine grades in the northern area had an index of 82.7, on the East-side, 87.1; in the central area, 87.9; in the southern area, 88.9; and, on the West-side, 90.4.

Table 7.- Average grade-index of machine-picked and hand-picked bales, 51 San Joaquin growers, 1949 crop

| Area | Number of Growers 1/ | Average |  |  | Range in Grade Indexes |  |  |
|---|---|---|---|---|---|---|---|
|  |  | Mach.-picked | Hand-picked | Difference 2/ | Mach.-picked | Hand-picked | Difference 2/ |
|  |  | Index | Index | Index | Index | Index | Index |
| South | 9 | 95.5 | 94.3 | +1.2 | 88.9-98.8 | 86.9-103.4 | -3.0 to +2.8 |
| East-side | 12 | 89.4 | 96.7 | -7.3 | 87.1-94.1 | 86.4-101.1 | + .7 to -10.0 |
| Central | 9 | 90.2 | 91.7 | -1.4 | 87.9-93.6 | 88.5-93.6 | 0 to -2.3 |
| West-side | 9 | 94.7 | 96.7 | -2.0 | 90.4-98.2 | 94.5-100.5 | - .5 to -10.0 |
| North | 12 | 88.3 | 95.2 | -6.9 | 82.7-94.7 | 82.3-100.3 | -13.4 to +5.5 |
| San Joaquin Valley | 51 | 91.8 | 95.4 | -3.6 | 82.7-98.8 | 82.3-103.4 | + .7 to -10.0 |

1/ Includes only those interviewed growers for whom it was possible to identify bales by method of picking.

2/ Minus sign indicates difference in favor of hand; plus sign, in favor of machine.

The grower in the southern area who had high grades, had machine picked 221 bales averaging Middling or better during October, 145 bales averaging between Middling and Strict Low Middling during November, 135 bales averaging Strict Low Middling during December. The grower who had low grades in the northern area started with Low Middling grades in November and finished with Good Ordinary grades in early December.

As a general rule, growers with high season-average machine grades were those who maintained high grades throughout the picking season. Those with average season-grades started with high grades at the beginning of the season but their cotton declined in grade throughout the season. Growers with low season-average grades started with low grades and their grades declined further during the season. Growers who had abnormal picking seasons, either unusually early or unusually late, were excluded in these comparisons.

## Discussion

Picking in the 1949 season was probably not wholly representative of the quality of future machine picking. Many new machines were used for the first time by inexperienced growers with inexperienced machine operators. Also the crop was very large, about 30 percent larger than 1948 and 48 percent larger than 1950.[14] In the effort to get this large crop harvested, mechanical

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[14] As indicated by the October 1, 1950 crop report.

harvesters worked at times in unfavorable weather and field conditions. Representative observers in the ginning industry reported that the crop strained the capacity of gins so that, in general, ginning was done too fast.[15] Better grades from machine-picked cotton should prevail in the 1950 season with comparable weather. The crop will be smaller and both machine operators and ginners will have had more experience with requirements of machine picking; more gins will be better equipped with machinery.

The somewhat lower machine-picked grades in the northern part of the Valley were to be expected in 1949 because that area had had less experience with machine picking and ginning. Grassy fields also were a common difficulty, perhaps of more influence than lack of experience. Growers commonly attempted to machine pick grassy fields because they were under pressure to get the crop harvested, and hand pickers were scarce or unavailable. Good machine-picked grades on the West-side were to be expected because growers there had used machines longer and because fields there generally have less weeds and grass.

Variation among gins within the same sub-area were also to be expected for several reasons. Some gins were better equipped with cleaning and drying machinery. Some ginners had had more experience with machine-picked cotton. Some gins were operated above normal (or rated) capacity a longer part of the season. At this writing the results at individual gins have not been fully analyzed or explained in terms of variation in the gin situation. It is expected that that will be done in a more complete report to follow.

Variation among gins in week-by-week pattern of grades of machine-picked versus hand-picked cotton likewise has not been thoroughly analyzed or explained. It is not certain that patterns at the selected gins are representative of the respective areas. Taking the patterns of the eight gins together, however, they suggest that the spread between the grades of machine and hand cotton does gradually narrow as the season advances, but not so sharply as some have supposed.

Numerous reasons may be cited for the great variation in grade of machine-picked cotton among growers. The fact that some growers in every sub-area were able to obtain good season-average grades indicates that successful machine picking is possible in all areas. Successful machine picking demands that the cotton be grown with mechanical harvest in mind. The rows must be properly spaced, the fields kept clean of weeds and grass, and the ground surface left smooth and free of clods. Recent research at the Shafter Station indicates that the cross-row, ground profile is also important. If the ground is left higher in the stalk row than between the rows, the plant-lifters on the machine have more space to feed low growing branches into the machine. Dead leaves are more likely to fall away from the cotton stalk, so the machine is less likely to pick up dead leaves.

In regard to grade-loss as a cost of machine harvest, machine-picked bales averaged $10.32 a bale lower in loan value than hand-picked bales. Because the loan value differential was different in the various areas of the Valley it seems reasonable to assign different charges for grade-loss. The difference in loan value amounted to $10.85 in the southern area, $14.72 on the East-side, $11.68 in the central area, $8.06 on the West-side, and $19.75 in the northern area. These are the charges for grade-loss to be added to the cost of machine picking.

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[15] Some estimates place the 1949 crop at 10 percent above optimum ginning capacity.

Some might argue that no "grade loss" should be charged to mechanical harvesting. Machines picked some 15 percent of the 1949 crop, hence the whole harvest was completed earlier than if picked entirely by hand. Even with the help of machines, about 15 percent of the crop was not picked until after December thirteenth.[16] Without machines, even more of the crop (perhaps 15 percent more) would have been harvested after mid-December, when the standing cotton and the ginned lint are of lower grades. California cotton ginned between mid-December and mid-January averaged Low Middling (grade-index of 85.7). Machine-picked bales for the entire season averaged about one-fourth of a grade below Strict Low Middling (grade-index 91.8). The difference in loan value of a Strict Low Middling and a Low Middling bale was about $25. Therefore, it might be reasonable to assume that (some) 205,000 [17] bales of cotton were $18.75 a bale higher in value, though machine-picked, than they would have been hand-picked, at a later date. That is to say, a machine-picked bale in October was worth more than a hand-picked bale in December. But the individual grower who uses or contemplates using a machine, must consider grade-loss as a cost of machine harvesting. Individual growers, on the average, received lower grades when they used machines. They could have used hand pickers and obtained higher grades, but not all of them could have obtained enough hand pickers. In a sense, growers who used machines (and took lower grades) made it possible for other growers to complete their harvest with hand pickers (and get higher grades). In this sense, grade-loss seems a real and direct loss to growers who use machines. The average grower has been willing, however, to accept his loss in grade in view of his saving in direct costs in machine harvesting.

## PICKING EFFICIENCY OF MECHANICAL HARVESTERS

As previously stated, the net economic advantage of machine harvesting, compared with hand picking, must consider not only the (a) cost of picking but also (b) comparative lint grades, and (c) comparative field waste. Picking costs and lint grades of machine-versus-hand picking were discussed in earlier sections. If field waste is greater in machine than in hand picking, the field value of the additional seed cotton left by the machine, must be charged as part of the cost of mechanical harvesting.

Field waste means open seed cotton left in the field unpicked. Thus, field waste, or conversely, picking efficiency, is expressed as a percentage of the total seed cotton available for picking at the time of harvesting. Actually there are two criteria for comparing machine-harvesting efficiency. One is an absolute criterion answering the question, "Does the machine pick all the seed cotton?" The other is the efficiency of hand picking. Growers are, of course, interested in both comparisons. They want their machines to be as efficient as possible, but, in terms of economic advantage, they must compare machine with hand picking, the only alternative harvesting method available.

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[16] Computed from Cotton Quality Reports, Production and Marketing Administration, Bakersfield.

[17] It is assumed the 900 machines each picked 228 bales, the average found among interviewed growers.

A mechanical harvester can contribute to field waste in numerous ways. Like any other mechanical device, it is limited to a strict mechanical pattern. It cannot see and therefore does not go back and pick a stray boll, once missed. The machine cannot pick cleanly if permitted to wander off the row. It sometimes misses the lower bolls--those six inches or less from the ground; this is more noticeable when the drums cannot be operated close to the ground owing to roughness or clods. Another characteristic of machine-picked fields is the presence of "tags"--locks or parts of locks streaming from branches of the cotton plants. Again, if the machine becomes clogged, some cotton usually is soiled and must be discarded in the cleaning. In these ways machine picking can lead to excessive field waste.

Field waste is measured by hand gleaning behind the harvester, a time-consuming job that, if representative, must include many field conditions. This was beyond the scope of the present study. Very few of the growers interviewed had made any actual measurements of field waste. Consequently we have relied on efficiency studies made at the United States Cotton Field Station at Shafter for information.18/ Measurements of field waste at the Station were carefully done, under controlled conditions; these results are the most reliable data available.

Over-all efficiency of machine harvesting was 96.5 percent at the Shafter Station in the 1949 season. This means that at the end of the season, after second picking had been completed, the harvester had left in the field 3.5 percent of the seed cotton available for picking. Efficiency was higher in 1949 than in previous seasons: 93.4 percent in 1948, and 92.4 percent in 1947.

How do these efficiencies compare with hand picking? The Shafter experiments included no hand picking in 1949, or 1947. But the mechanization project in 1948 measured hand picking efficiency at 97.6 percent. This figure appears to be about the maximum efficiency to be expected in hand picking.

These efficiencies in machine and hand picking at the Shafter Station probably are correspondingly higher than those attained by the average grower. However, it is believed they represent the approximate relationship between machine and hand picking efficiencies that growers have experienced; that is, hand picking is about 1.1 percent more efficient than machine picking. These efficiencies can serve to indicate the economic importance of field-loss.

The average yield among interviewed growers (1949) was 2,171 pounds of seed cotton harvested per acre. If machine harvesting was 96.5 percent efficient, the natural yield (amount available for picking) was 2,250 pounds per acre. Thus, machines left in the field 79 pounds of seed cotton per acre. In comparable cotton it is estimated that hand pickers picked 2,196 pounds of seed cotton, and left in the field 54 pounds per acre. Thus, machines left about 25 pounds more than hand pickers per acre. What was the value of the loss? The value of seed cotton in the field, before it was picked, in 1949 was about $7.28 per

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18/ Hoover, Marvin, COTTON MECHANIZATION, Agricultural Extension Service, College of Agriculture, University of California, from Project Report, Project No. 1361, Fairbanks, J. P., and Smith, K.O. Agricultural Engineering Division, page 3.

hundredweight.[19] The value of 25 pounds was therefore about $1.82. The average value of field loss per harvested bale was about $1.20.

## Discussion

Although few growers had measured the picking efficiency of their machine harvesters, most growers said that machines did a more thorough job of "cleaning the field" in 1949 than in previous years. Very few growers were any longer concerned about field waste by the end of the 1949 season. This absence of concern may be partly because field waste actually was not large, partly because growers have learned machine-picked fields appear to have more waste than turns out to be true, partly because they have found that machines gather in second picking some of the waste from first picking, and finally, because they now realize more fully the extent of waste from ordinary or poor hand picking.

In general, growers reported the opinion that field waste is lower relatively in rank-growing, high-yielding cotton. In such cotton a smaller percentage of the bolls are close to the ground surface where they are hard to reach. Another general conclusion is that competent skilled machine operators are essential to efficient picking. Some growers limited the hours per work-shift to avoid over-fatigue and lowered efficiency of machine operators. When in actual operation, the two most frequently cited cautions by growers was (1) to keep the machine on the row, and (2) to keep the machine clean.

Research at the Shafter Station indicates that row-spacing of 40 inches, with cotton stalks 4 to 8 inches apart in the row, provides the best conditions for mechanical harvesting. It also indicates that,

> "Consideration should be given the following points in laying cotton by:
> The rows should be uniform in height, width and shape,
> The rows should be smooth and free of clods,
> The crest should be at the base of the stalk,
> Furrows should be wide enough to permit steering of the picker."[20]

## EFFECT OF MACHINE PICKING ON GIN TURNOUT

Gin turnout of machine-picked cotton has been of interest to growers, ginners and the cotton industry. Gin turnout is the ratio, in pounds, of lint to seed cotton; turnout percent is this ratio expressed as a percentage. Seed cotton usually contains some leaves, stems, sticks and moisture. The reason turnout is important is that it is an inverse expression of the amount of foreign matter (trash, moisture, etc.) in a trailer-load of cotton.[21] When

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[19] Field value of seed cotton equals: the value of 37.1 pounds of lint ($9.83), plus 58.9 pounds of cotton seed ($1.40), minus (hand) harvesting costs ($3.25), and ginning costs ($.70).

[20] Ibid, page 3.

[21] Turnout may also reflect thoroughness with which the gin removes lint from seed, but that fact is more directly determined by inspection of seed as it comes from the gin.

[illegible]

[illegible]

Although few growers had mentioned the possibility of [illegible] machine [illegible] concluded that field waste [illegible] up the end of the [illegible]. These reports of [illegible] [illegible]

[illegible]

Research at the [illegible] Station [illegible] with cotton stripping [illegible]

"Consideration should be given the following points in laying out [illegible]

[illegible]

The rows should be smooth and free of clods.

[illegible]

Furrows should [illegible]"

[illegible]

The amount of moisture in seed cotton [illegible]

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[illegible]

[illegible] Ibid, p. 36.

[illegible]

turnout is high, foreign matter is low. Low foreign matter (high turnout) is desired because foreign matter makes it more difficult to produce good grades of cotton and because excess foreign matter increases the cost of ginning, inasmuch as charges for ginning and drying are based on the weight of seed cotton. Although high turnout percentage is not as vitally important to the grower as good grades, a low turnout may indicate to him the reason for poor grades — the presence of too much trash.

Mechanical harvesters can reduce gin turnout by collecting with the seed cotton more trash than hand pickers do, or by adding moisture from the spindle-moisteners. On the other hand, mechanical harvesters can *improve* turnout if they collect less trash than hand pickers do.

The weight of seed cotton and weight of bales produced were tabulated from the gin statements for the interviewed growers. These data were used to compare gin turnout of machine- and hand-picked cotton by season-average and by periods through the season.

Among the 63 interviewed growers, the season-average gin turnout of machine-picked cotton (36.5 percent) was less than one percentage point lower than hand-picked cotton (37.1 percent).[22] (Table 8). On the average it required 1,370 pounds of machine-picked seed cotton compared to 1,348 pounds of hand-picked seed cotton, to make a 500-pound bale of lint cotton. Gin turnout of machine-picked cotton was also lower, but not to the same extent, in each of the sub-areas — except the central area. In that sub-area, gin turnout of machine-picked cotton (37.2 percent) was actually higher for the season than turnout of hand-picked cotton (35.5 percent). It may be noted that the central area had the highest machine turnout and the lowest hand turnout of any area. By sub-areas, machine turnout was 2.4 percentage points lower than hand in the southern area, 0.7 points lower on the East-side and the West-side, 1.1 points lower in the northern area, and 1.7 points *higher* in the central area.

For the growers interviewed, gin turnout of hand-picked cotton followed the usual pattern, starting high and declining steadily throughout the season. In contrast, machine-picked turnout increased from September (36.7 percent) to October (37.1 percent), it nearly equaled hand-picked turnout in mid-season, and was actually higher than hand-picked turnout in late season picking (Table 8). (Neither snaps nor bollies were included in hand picking.) In short, turnout of machine-picked cotton improved relative to the turnout of hand-picked throughout the season, a relationship that was repeated in each of the sub-areas, with some variations (Table 8).

On the whole, gin turnout of machine-picked cotton was remarkably good. Apparently the concern people had when machines first came into use was unjustified. The reason machine-picked turnout showed up less favorably early in the season, apparently, was that machines collected more green leaves and other trash than the hand pickers did. After the cotton had defoliated, machine performance was comparable to hand picking. The reason that machine-picked turnout compared favorably late in the season may have been due to very poor hand picking at that time.

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[22] Gross weight of bales was used throughout in calculating gin turnout.

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Table 8.- Gin turnout percent of machine and hand-picked cotton of survey growers, by four-week periods, 1949 crop

| Four-week period | San Joaquin Valley | | | Areas | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | South | | | East-side | | |
| | Mach.-picked | Hand-picked | Difference 1/ | Mach.-picked | Hand-picked | Difference 1/ | Mach.-picked | Hand-picked | Difference 1/ |
| | % | % | % | % | % | % | % | % | % |
| 1st (Sept.11-Oct.8) | 36.7 | 39.1 | -2.4 | 32.4 | 37.8 | -5.4 | 38.4 | 39.2 | - .8 |
| 2nd (Oct. 9 -Nov.5) | 37.2 | 37.9 | - .7 | 36.2 | 37.4 | -1.2 | 36.6 | 37.9 | -1.3 |
| 3rd (Nov. 6 -Dec.3) | 36.8 | 36.8 | -- | 35.0 | 37.1 | -2.1 | 36.5 | 35.7 | + .8 |
| 4th (Dec. 4 - 31) | 34.7 | 35.0 | - .3 | 31.9 | 36.4 | -4.5 | 34.5 | 33.4 | +1.1 |
| 5th (Jan. 1 - 28) | 32.2 | 30.7 | -1.5 | 30.0 | 29.0 | +1.0 | 33.0 | 30.8 | +2.2 |
| Season-average 2/ | 36.5 | 37.1 | - .6 | 34.4 | 36.8 | -2.4 | 36.2 | 36.9 | - .7 |

| Four-week period | Areas | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Central | | | West-side | | | North | | |
| | Mach.-picked | Hand-picked | Difference 1/ | Mach.-picked | Hand-picked | Difference 1/ | Mach.-picked | Hand-picked | Difference 1/ |
| | % | % | % | % | % | % | % | % | % |
| 1st (Sept.11-Oct.8) | ---- | ---- | ---- | 37.3 | 39.3 | -2.0 | 38.4 | 39.2 | - .8 |
| 2nd (Oct. 9 -Nov.5) | 37.3 | 38.0 | - .7 | 37.8 | 37.9 | - .1 | 37.3 | 38.1 | - .8 |
| 3rd (Nov. 6 -Dec.3) | 37.8 | 37.6 | + .2 | 37.0 | 37.1 | - .1 | 36.4 | 37.1 | - .7 |
| 4th (Dec. 4 - 31) | 36.2 | 35.2 | +1.0 | 35.2 | 36.6 | -1.4 | 34.5 | 35.3 | - .8 |
| 5th (Jan. 1 - 28) | 33.4 | 31.5 | +1.9 | 31.0 | 31.1 | -0.1 | 33.3 | 27.8 | +5.5 |
| Season-average 2/ | 37.2 | 35.5 | +1.7 | 36.9 | 37.6 | - .7 | 36.5 | 37.6 | -1.1 |

1/ Minus sign indicates machine below hand, plus sign, machine above hand.

2/ Season-average of all cotton picked, not a simple average of the five four-week periods.

## ATTACHED TABLES

### Table 9.- Average number of machine-picked and hand-picked bales harvested by 63 growers in the San Joaquin Valley, 1949

(Includes machine custom picking for other growers)

| Area | Number of Growers | Total Harvested | Both picks | | 1st pick | | 2nd pick | |
|---|---|---|---|---|---|---|---|---|
| | | | Mach.-picked | Hand-picked | Mach.-picked | Hand-picked | Mach.-picked | Hand-picked |
| | | Bales | Bales | Bales | Bales | Bales | Bales | Bales |
| South | 15 1/ | 443 | 258 | 185 | 201 | 144 | 57 | 41 |
| East-side | 16 | 428 | 245 | 183 | 185 | 156 | 60 | 27 |
| Central | 9 2/ | 350 | 201 | 149 | 183 | 53 | 18 | 96 |
| West-side | 9 3/ | 601 | 292 | 309 | 244 | 278 | 48 | 31 |
| North | 14 4/ | 357 | 158 | 199 | 116 | 170 | 42 | 29 |
| San Joaquin Valley | 63 5/ | 428 | 229 | 200 | 182 | 165 | 47 | 35 |

Note: Averages are for all growers interviewed whether or not they all used machines or hand pickers in first or second picking.

1/ Four growers had no hand picking, three had no machine first picking, and one had no machine second picking.

2/ Two growers had no hand picking, and one had no machine second picking.

3/ Four growers had no hand picking.

4/ One grower had no hand picking, one grower had no machine first picking.

5/ Eleven growers had no hand picking, four had no machine first picking, and two had no machine second picking.

Table 10.- Usual operating expenses for mechanical harvesters, tractors and labor by 63 San Joaquin Valley growers, 1949

| Item | San Joaquin Valley | Sub-Areas | | | | |
|---|---|---|---|---|---|---|
| | | South | East-side | Central | West-side | North |
| Number of records | 63 | 15 | 16 | 9 | 9 | 14 |
| Acres, once over | 284 | 263 | 309 | 273 | 317 | 265 |
| Machine hours | 407 | 414 | 427 | 316 | 479 | 387 |
| Bales harvested | 229 | 258 | 245 | 201 | 292 | 158 |
| **Harvester Expense** | | | Dollars | | | |
| Pre-season repair | 505 | 398 | 583 | 503 | 503 | 472 |
| Seasonal repair | 196 | 230 | 240 | 145 | 145 | 173 |
| Mount, dismount | 79 | 69 | 91 | 119 | 63 | 61 |
| Spindle oil | 58 | 49 | 63 | 92 | 62 | 40 |
| Grease | 6 | 6 | 8 | 5 | 6 | 7 |
| Wetting agent | 25 | 26 | 20 | 15 | 36 | 29 |
| Total | 869 | 778 | 1005 | 879 | 815 | 782 |
| **Tractor Expense 1/** | | | | | | |
| Fuel | 133 | 143 | 140 | 107 | 159 | 113 |
| Oil | 8 | 7 | 9 | 7 | 8 | 7 |
| Oil filter | 4 | 4 | 4 | 4 | 4 | 4 |
| Gear grease | 2 | 2 | 2 | 2 | 2 | 2 |
| Total | 147 | 156 | 155 | 120 | 173 | 126 |
| **Labor Expense** | | | | | | |
| Operating | 460 | 402 | 472 | 388 | 608 | 459 |
| Bonus 2/ | 46 | 97 | 23 | 55 | 51 | 7 |
| Service & repair | 84 | 65 | 89 | 61 | 103 | 100 |
| Farm shop | 8 | 11 | 3 | 1 | 1 | 20 |
| Compensation ins. | 7 | 6 | 7 | 6 | 9 | 6 |
| Total | 605 | 581 | 594 | 511 | 772 | 592 |
| Total Expenses | 1,621 | 1,515 | 1,754 | 1,510 | 1,760 | 1,500 |

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1/ Includes only operating costs in harvesting cotton. Repair costs were included in overhead for convenience in prorating the share charged to harvesting cotton.

2/ The following number of growers paid bonuses averaging the indicated amounts, by sub-areas: South, 7 growers, $208; East-side, 2 growers, $188; Central, 2 growers, $247; West-side, 1 grower, $460; North, 1 grower, $94.

Table 11.- Usual investment in mechanical harvesters and tractors, and overhead costs for 63 San Joaquin Valley growers, 1949

| Item | San Joaquin Valley | Sub-Areas | | | | |
|---|---|---|---|---|---|---|
| | | South | East-side | Central | West-side | North |
| Number of records | 63 | 15 | 16 | 9 | 9 | 14 |
| Acres, once over | 284 | 263 | 309 | 273 | 317 | 265 |
| Machine hours | 407 | 414 | 427 | 316 | 479 | 387 |
| Bales picked | 229 | 258 | 245 | 201 | 292 | 158 |
| <u>Investment</u> | | Dollars | | | | |
| Harvester: | | | | | | |
| Original cost | 6,459 | 6,501 | 6,450 | 6,485 | 6,386 | 6,455 |
| Less salvage value | 969 | 975 | 968 | 973 | 958 | 969 |
| Total depreciation | 5,490 | 5,526 | 5,482 | 5,512 | 5,428 | 5,486 |
| Average investment | 3,714 | 3,738 | 3,709 | 3,729 | 3,672 | 3,712 |
| Tractor: | | | | | | |
| Original cost | 2,950 | 2,817 | 3,008 | 2,918 | 2,874 | 3,094 |
| Less salvage value | 442 | 422 | 451 | 437 | 431 | 464 |
| Total depreciation | 2,508 | 2,395 | 2,557 | 2,481 | 2,443 | 2,630 |
| Average investment | 1,696 | 1,620 | 1,730 | 1,678 | 1,653 | 1,779 |
| <u>Annual Overhead Costs</u> | | | | | | |
| Harvester: | | | | | | |
| Depreciation | 1,112 | 1,123 | 1,133 | 1,101 | 1,093 | 1,097 |
| Interest on av. invest. | 149 | 150 | 148 | 149 | 147 | 149 |
| General property taxes | 123 | 165 | 106 | 121 | 72 | 132 |
| Insurance | 33 | 33 | 23 | 50 | 37 | 32 |
| Total | 1,417 | 1,471 | 1,410 | 1,421 | 1,349 | 1,410 |
| Tractor: | | | | | | |
| Depreciation | 371 | 350 | 393 | 378 | 351 | 376 |
| Interest on Av. invest. | 68 | 65 | 69 | 67 | 66 | 71 |
| General Property Taxes | 36 | 45 | 32 | 37 | 20 | 41 |
| Insurance | 15 | 14 | 11 | 22 | 17 | 15 |
| Repairs 1/ | 100 | 100 | 100 | 100 | 100 | 100 |
| Total | 590 | 574 | 605 | 604 | 554 | 603 |
| <u>Charged to harvesting cotton</u> | | | | | | |
| Percent of annual | 53.7 | 58.3 | 50.5 | 39.5 | 56.3 | 60.2 |
| Amount, dollars | 317 | 335 | 306 | 239 | 312 | 363 |

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1/ Included in overhead for convenience in allocating proportionate share to cotton harvesting.

Table 12.- Materials and labor used in harvesting cotton mechanically by 63 San Joaquin Valley growers, 1949

| Item | unit | San Joaquin Valley | Sub-Areas | | | | |
|---|---|---|---|---|---|---|---|
| | | | South | East-side | Central | West-side | North |
| Number of records | | 63 | 15 | 16 | 9 | 9 | 14 |
| Harvester | | | | | | | |
| Spindle oil | gal. | 107 | 93 | 126 | 144 | 109 | 75 |
| Wetting agent | gal. | 5 | 5 | 4 | 3 | 6 | 5 |
| Grease | lb. | 42 | 41 | 41 | 35 | 38 | 49 |
| Tractor | | | | | | | |
| Fuel | gal. | 809 | 817 | 836 | 667 | 979 | 750 |
| Cylinder oil | qt. | 44 | 39 | 53 | 42 | 47 | 38 |
| Oil filter | no. | 4 | 4 | 4 | 4 | 6 | 4 |
| Grease | lb. | 13 | 13 | 13 | 13 | 13 | 13 |
| Labor | | | | | | | |
| Operating | hr. | 407 | 414 | 427 | 316 | 479 | 387 |
| Service & repair | hr. | 75 | 66 | 84 | 48 | 86 | 86 |
| Mount & dismount[1] | hr. | 26 | 25 | 27 | 18 | 31 | 25 |
| Farm shop | hr. | 9 | 11 | 6 | 1 | 1 | 18 |
| Total labor | hr. | 517 | 516 | 544 | 383 | 597 | 516 |

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[1] Average for cases reporting.

## Table 13.- Number of machine-picked and hand-picked bales by grade at 35 San Joaquin Valley Gins, 1949 crop

| Grade | 35 Gins San Joaquin Valley | | Sub-Area | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | South (8 Gins) | | East-side (9 Gins) | | Central (2 Gins) | | West-side (12 Gins) | | North (4 Gins) | |
| | Machine-Picked | Hand-Picked | Mach.-Picked | Hand-Picked | Mach.-Picked | Hand-Picked | Mach.-Picked | Hand-Picked | Mach.-Picked | Hand-Picked | Mach.-Picked | Hand-Picked |
| White & Ex.Wh. | Number | Number | Number | Number | Number | Number | Number | Number | Number | Number | Number | Number |
| GM | 64 | 5,771 | 48 | 4,410 | --- | 587 | --- | 34 | 16 | 738 | --- | 2 |
| SM | 1,474 | 55,858 | 518 | 16,230 | 93 | 16,791 | 27 | 2,653 | 831 | 18,350 | 5 | 1,834 |
| M | 11,559 | 86,929 | 3,067 | 15,078 | 1,153 | 23,059 | 433 | 5,221 | 6,824 | 36,161 | 82 | 7,410 |
| SLM | 27,431 | 52,134 | 7,090 | 8,583 | 5,002 | 15,872 | 2,012 | 2,826 | 12,611 | 21,033 | 716 | 3,820 |
| LM | 13,284 | 13,874 | 2,869 | 1,600 | 3,856 | 4,311 | 901 | 903 | 4,655 | 4,719 | 1,003 | 2,341 |
| SGO | 2,658 | 3,244 | 399 | 868 | 652 | 782 | 444 | 213 | 645 | 941 | 518 | 440 |
| GO | 538 | 1,174 | 88 | 229 | 245 | 343 | 23 | 274 | 130 | 216 | 52 | 112 |
| Spotted | | | | | | | | | | | | |
| GM | 25 | 268 | 25 | 130 | --- | 59 | --- | 12 | --- | 27 | --- | 40 |
| SM | 600 | 3,530 | 422 | 846 | 22 | 1,426 | 16 | 182 | 134 | 454 | 6 | 622 |
| M | 1,301 | 3,943 | 605 | 396 | 51 | 1,676 | 62 | 185 | 514 | 530 | 69 | 1,156 |
| SLM | 694 | 1,080 | 255 | 124 | 29 | 363 | 15 | 27 | 256 | 176 | 139 | 390 |
| LM | 177 | 968 | 65 | 224 | --- | 283 | --- | 77 | 91 | 151 | 21 | 233 |
| Tinged | | | | | | | | | | | | |
| GM | --- | 1 | --- | --- | --- | 1 | --- | --- | --- | --- | --- | --- |
| SM | --- | 7 | --- | --- | --- | 5 | --- | --- | --- | --- | --- | 2 |
| M | --- | 263 | --- | 242 | --- | 20 | --- | --- | --- | 1 | --- | --- |
| SLM | --- | 51 | --- | 23 | --- | 11 | --- | 1 | --- | 1 | --- | 15 |
| LM | --- | 32 | --- | 4 | --- | 4 | --- | 5 | --- | --- | --- | 19 |
| Gray | | | | | | | | | | | | |
| GM | 12 | 112 | 12 | 107 | --- | --- | --- | 1 | --- | 4 | --- | --- |
| SM | 435 | 967 | 349 | 365 | 26 | 168 | 5 | 211 | 55 | 160 | --- | 63 |
| M | 1,495 | 5,852 | 650 | 711 | 136 | 1,888 | 448 | 1,008 | 261 | 1,430 | --- | 817 |
| SLM | 683 | 1,364 | 194 | 64 | 83 | 399 | 227 | 284 | 168 | 344 | 11 | 273 |
| Below Grade | 193 | 389 | 65 | 95 | 73 | 155 | --- | 63 | 41 | 10 | 14 | 66 |
| Total | 62,623 | 237,811 | 16,721 | 50,329 | 11,421 | 68,203 | 4,613 | 14,178 | 27,232 | 85,446 | 2,636 | 19,655 |
| Av.Grade-Index | 91.8 | 97.4 | 92.4 | 98.9 | 89.6 | 97.2 | 89.1 | 95.4 | 93.3 | 97.7 | 85.8 | 94.4 |
| Av. Loan Value | 132.52 | 142.84 | 133.94 | 144.79 | 127.67 | 142.39 | 127.97 | 139.65 | 135.90 | 143.96 | 117.20 | 136.95 |

## Table 14.- Percentage distribution of machine-picked and hand-picked bales at 35 gins, San Joaquin Valley, 1949 crop

| Grade | San Joaquin Valley |  | Areas |  |  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  | South |  | East-side |  | Central |  | West-side |  | North |  |
|  | Machine-Picked | Hand-Picked | Mach.-Picked | Hand-Picked | Mach.-Picked | Hand-Picked | Mach.-Picked | Hand-Picked | Mach.-Picked | Hand-Picked | Mach.-Picked | Hand-Picked |
|  | % | % | % | % | % | % | % | % | % | % | % | % |
| White & Ex.Wh. |  |  |  |  |  |  |  |  |  |  |  |  |
| GM | .1 | 2.4 | .3 | 8.8 | -- | .9 | -- | .2 | .1 | .9 | -- | -- |
| SM | 2.4 | 23.5 | 3.1 | 32.2 | .8 | 24.6 | .6 | 18.7 | 3.0 | 21.5 | .2 | 9.3 |
| M | 18.4 | 36.6 | 18.3 | 30.0 | 10.1 | 33.8 | 9.4 | 36.9 | 25.0 | 42.3 | 3.1 | 37.7 |
| SLM | 43.8 | 21.9 | 42.4 | 17.1 | 43.9 | 23.3 | 43.7 | 20.0 | 46.3 | 24.6 | 27.2 | 19.4 |
| LM | 21.2 | 5.8 | 17.2 | 3.2 | 33.8 | 6.3 | 19.6 | 6.4 | 17.1 | 5.5 | 38.0 | 11.9 |
| SGO | 4.2 | 1.4 | 2.4 | 1.7 | 5.7 | 1.2 | 9.6 | 1.5 | 2.4 | 1.1 | 19.7 | 2.2 |
| GO | .9 | .5 | .5 | .5 | 2.1 | .5 | .5 | 1.9 | .5 | .3 | 2.0 | .6 |
| (White) | (91.0) | (92.1) | (84.2) | (93.5) | (96.4) | (90.6) | (83.4) | (85.6) | (94.4) | (96.2) | (90.2) | (81.1) |
| Spotted |  |  |  |  |  |  |  |  |  |  |  |  |
| GM | -- | .1 | .1 | .3 | -- | .1 | -- | .1 | -- | -- | -- | .2 |
| SM | 1.0 | 1.5 | 2.5 | 1.7 | .2 | 2.1 | .3 | 1.3 | .5 | .5 | .2 | 3.2 |
| M | 2.1 | 1.7 | 3.6 | .8 | .4 | 2.5 | 1.3 | 1.3 | 1.9 | .6 | 2.6 | 5.9 |
| SLM | 1.1 | .4 | 1.5 | .2 | .3 | .5 | .3 | .2 | .9 | .2 | 5.3 | 2.0 |
| LM | .3 | .4 | .4 | .4 | -- | .4 | -- | .5 | .3 | .2 | .8 | 1.2 |
| (Spotted) | (4.5) | (4.1) | (8.1) | (3.4) | (.9) | (5.6) | (1.9) | (3.4) | (3.6) | (1.5) | (8.9) | (12.5) |
| Tinged |  |  |  |  |  |  |  |  |  |  |  |  |
| GM | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| SM | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| M | -- | .1 | -- | .5 | -- | -- | -- | -- | -- | -- | -- | -- |
| SLM | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | .1 |
| LM | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | .1 |
| (Tinged) | -- | (.1) | -- | (.5) | -- | -- | -- | -- | -- | -- | -- | (.2) |
| Gray |  |  |  |  |  |  |  |  |  |  |  |  |
| GM | -- | -- | .1 | .2 | -- | -- | -- | -- | -- | -- | -- | -- |
| SM | .7 | .4 | 2.1 | .7 | .2 | .2 | .1 | 1.5 | .2 | .2 | -- | .3 |
| M | 2.4 | 2.5 | 3.9 | 1.4 | 1.2 | 2.8 | 9.7 | 7.1 | 1.0 | 1.7 | -- | 4.2 |
| SLM | 1.1 | .6 | 1.2 | .1 | .7 | .6 | 4.9 | 2.0 | .6 | .4 | .4 | 1.4 |
| (Gray) | (4.2) | (3.5) | (7.3) | (2.4) | (2.1) | (3.6) | (14.7) | (10.6) | (1.8) | (2.3) | (.4) | (5.9) |
| Below Grade | .3 | .2 | .4 | .2 | .6 | .2 | -- | .4 | .2 | -- | .5 | .3 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Table 15.- Weekly grade-indexes of machine-picked and hand-picked cotton at eight selected San Joaquin Valley gins, 1949 crop

| Week of harvest season 1/ | Gin N-1 | | | Gin W-3 | | | Gin W-4 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mach.-picked | Hand-picked | Difference 2/ | Mach.-picked | Hand-picked | Difference 2/ | Mach.-picked | Hand-picked | Difference 2/ |
| 1st | — | — | — | — | — | — | — | — | — |
| 2nd | — | 100.8 | — | — | 102.0 | — | 95.8 | 104.3 | -8.5 |
| 3rd | — | 100.7 | — | 93.6 | 104.1 | -10.5 | 99.2 | 104.8 | -5.6 |
| 4th | — | 99.5 | — | 100.6 | 103.9 | - 3.3 | 97.1 | 103.8 | -6.7 |
| 5th | 93.6 | 100.1 | - 6.5 | 96.3 | 103.7 | - 7.4 | 98.9 | 103.3 | -4.4 |
| 6th | 93.1 | 100.3 | - 7.2 | 96.1 | 103.5 | - 7.4 | 99.0 | 101.3 | -2.3 |
| 7th | 85.3 | 97.6 | -12.3 | 95.3 | 102.7 | - 7.4 | 96.8 | 102.3 | -5.5 |
| 8th | 87.5 | 99.8 | -12.3 | 98.9 | 102.3 | - 3.4 | 96.0 | 101.8 | -5.8 |
| 9th | 85.4 | 95.7 | -10.3 | 93.2 | 99.2 | - 6.0 | 94.3 | 99.7 | -5.4 |
| 10th | 86.7 | 94.7 | - 8.0 | 90.0 | 96.0 | - 6.0 | 95.5 | 99.3 | -3.8 |
| 11th | 83.5 | 88.0 | - 4.5 | 90.2 | 95.5 | - 5.3 | (95.5) | (98.2) | -(2.7) |
| 12th | 79.3 | 85.9 | - 6.6 | 86.0 | 94.8 | - 8.8 | 95.4 | 97.1 | -1.7 |
| 13th | (74.2) | 83.5 | - 9.3 | 88.6 | 95.4 | - 6.8 | 90.1 | 98.8 | -8.7 |
| 14th | 68.0 | 84.8 | -16.8 | 81.7 | 85.5 | - 3.8 | 91.9 | 96.2 | -4.3 |
| 15th | — | 82.9 | — | 79.9 | 82.5 | - 2.6 | 87.9 | 95.3 | -7.4 |
| 16th | — | 79.9 | — | 76.8 | 85.3 | - 8.5 | 86.2 | 92.3 | -6.1 |
| 17th | — | 78.8 | — | 76.0 | 88.1 | -12.1 | 82.1 | (90.0) | — |
| 18th | — | 83.9 | — | — | — | — | — | — | — |

| Week of harvest season 1/ | Gin E-5 | | | Gin E-6 | | | Gin S-7 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mach.-picked | Hand-picked | Difference 2/ | Mach.-picked | Hand-picked | Difference 2/ | Mach.-picked | Hand-picked | Difference 2/ |
| 1st | — | — | — | — | — | — | — | — | — |
| 2nd | — | 100.6 | — | — | 102.5 | — | — | 103.2 | — |
| 3rd | 95.0 | 101.8 | - 6.8 | — | 100.5 | — | 96.4 | 96.0 | - .4 |
| 4th | 97.6 | 102.2 | - 4.6 | 93.3 | 102.0 | - 8.7 | 95.0 | 103.2 | -8.2 |
| 5th | 92.0 | 98.9 | - 6.9 | 96.1 | 100.7 | - 4.6 | 94.2 | 101.2 | -7.0 |
| 6th | 93.2 | 100.6 | - 7.4 | 91.1 | 102.3 | -11.2 | 92.3 | 102.5 | -10.2 |
| 7th | 85.4 | 98.7 | -13.3 | 88.5 | 100.4 | -11.9 | 92.1 | 100.4 | -8.3 |
| 8th | 92.4 | 99.7 | - 7.3 | 92.2 | 99.5 | - 7.3 | 93.2 | 101.3 | -8.1 |
| 9th | 88.4 | 96.7 | - 8.3 | 83.1 | 96.2 | -13.1 | 94.0 | 100.9 | -6.9 |
| 10th | 85.5 | 95.9 | -10.4 | 82.8 | 94.4 | -11.6 | 88.5 | 96.6 | -8.1 |
| 11th | 85.0 | 91.7 | - 6.7 | 80.5 | 93.7 | -13.2 | 86.7 | 97.4 | -10.7 |
| 12th | 77.3 | 89.8 | -12.5 | 75.4 | 92.4 | -17.0 | 85.0 | 93.8 | - 8.8 |
| 13th | 72.6 | 84.4 | -11.8 | 73.9 | 91.6 | -17.7 | 76.4 | 88.9 | -12.5 |
| 14th | 75.0 | 83.1 | - 8.1 | 69.2 | 86.0 | -16.8 | 81.1 | 82.5 | - 1.4 |
| 15th | (74.4) | 77.4 | — | 70.2 | 88.0 | -17.8 | 74.6 | 80.9 | - 6.3 |
| 16th | 73.9 | 79.6 | - 5.7 | 74.2 | 85.5 | -11.3 | 78.3 | 86.8 | - 8.5 |
| 17th | (73.8) | 78.3 | — | 79.1 | 82.6 | - 3.5 | 78.9 | 80.2 | - 1.3 |
| 18th | 73.7 | 76.1 | - 2.4 | 74.8 | — | — | 73.9 | 80.1 | - 6.2 |

1/ First week begins Sept. 11; eighteenth week ends Jan. 14.

2/ Minus sign indicates machine below hand.

Figures in parenthesis interpolated.

Continued

Table 15.- Weekly grade-indexes of machine-picked and hand-picked cotton at eight selected San Joaquin Valley gins, 1949 crop - Continued

| Week of harvest season 1/ | Gin S-8 | | | Gin C-2 | | | Total 8 Gins | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mach.-picked | Hand-picked | Difference 2/ | Mach.-picked | Hand-picked | Difference 2/ | Mach.-picked | Hand-picked | Difference 2/ |
| 1st | — | 102.3 | — | — | — | — | — | 102.3 | — |
| 2nd | — | 103.9 | — | — | — | — | 95.8 | 102.5 | -6.7 |
| 3rd | 98.6 | 103.9 | - 5.3 | — | 104.0 | — | 96.6 | 102.0 | -5.4 |
| 4th | 96.2 | 103.2 | - 7.0 | 97.1 | 102.6 | - 5.5 | 96.7 | 102.6 | -5.9 |
| 5th | 94.4 | 102.4 | - 8.0 | 96.1 | 102.5 | - 6.4 | 95.2 | 101.6 | -6.4 |
| 6th | 95.9 | 101.3 | - 5.4 | 93.5 | 101.9 | - 8.4 | 94.3 | 101.7 | -7.4 |
| 7th | 94.5 | 101.4 | - 6.9 | 94.0 | 102.0 | - 8.0 | 91.5 | 100.7 | -9.2 |
| 8th | 94.5 | 100.5 | - 6.0 | 94.1 | 100.9 | - 6.8 | 93.6 | 100.7 | -7.1 |
| 9th | 93.2 | 97.8 | - 4.6 | 93.4 | 96.3 | - 2.9 | 90.6 | 97.8 | -7.2 |
| 10th | 89.5 | 96.4 | - 6.9 | 90.0 | 95.5 | - 5.5 | 88.6 | 96.1 | -7.5 |
| 11th | 92.1 | 95.4 | - 3.3 | 90.2 | 97.5 | - 7.3 | 88.0 | 94.7 | -6.7 |
| 12th | 93.9 | 95.5 | - 1.6 | 83.6 | 95.3 | -11.7 | 84.5 | 93.1 | -8.6 |
| 13th | 91.1 | 93.6 | - 2.5 | 82.0 | 83.5 | - 1.5 | 81.1 | 90.0 | -8.9 |
| 14th | 89.0 | 93.3 | - 4.3 | 81.6 | 82.7 | - 1.1 | 79.7 | 86.8 | -7.1 |
| 15th | 89.0 | 92.2 | - 3.2 | 80.3 | 82.2 | - 1.9 | 79.5 | 85.2 | -5.7 |
| 16th | 87.9 | 91.2 | - 3.3 | 78.7 | 79.5 | - .8 | 79.4 | 85.0 | -5.6 |
| 17th | 88.3 | 86.0 | - 2.3 | (78.6) | 78.8 | — | 79.5 | 82.8 | -3.3 |
| 18th | 85.1 | 82.3 | - 2.8 | 78.5 | 76.6 | + 1.9 | 77.2 | 79.8 | -2.6 |

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1/ First week begins Sept. 11; eighteenth week ends Jan. 14.

2/ Minus sign indicates machine below hand; plus sign indicates hand below machine.

Figures in parenthesis interpolated.

Table 16.- Grade-index numbers and 1949 government loan values of 1 1/16-inch upland cotton, 1949 crop, California

| Grades | Colors | | | | |
|---|---|---|---|---|---|
| | White or Extra White | Spotted | Gray | Tinged | Yellow stained |
| | | Indexes 1/ | | | |
| Good Middling (GM) | 105 | 101 | 93 | 94 | 86 |
| Strict Good Middling (SGM) | 104 | 99 | 91 | 91 | 81 |
| Middling (M) | 100 | 93 | 84 | 82 | 73 |
| Strict Low Middling (SLM) | 94 | 83 | 75 | 75 | --- |
| Low Middling (LM) | 85 | 75 | --- | 68 | --- |
| Strict Good Ordinary (SGO) | 76 | --- | --- | --- | --- |
| Good Ordinary (GO) | 70 | --- | --- | --- | --- |
| | | (Below grades=60) | | | |
| | | 1949 loan values (cents per pound) 2/ | | | |
| Good Middling (GM) | 30.48 | 28.33 | 26.58 | 21.58 | 17.98 |
| Strict Good Middling (SGM) | 30.23 | 28.23 | 26.23 | 21.28 | 17.48 |
| Middling (M) | 29.83 | 26.28 | 25.38 | 18.43 | 15.73 |
| Strict Low Middling (SLM) | 27.98 | 20.58 | 20.18 | 15.58 | --- |
| Low Middling (LM) | 22.88 | 16.58 | --- | 13.28 | --- |
| Strict Good Ordinary (SGO) | 18.83 | --- | --- | --- | --- |
| Good Ordinary (GO) | 16.58 | --- | --- | --- | --- |
| | | (Below grade 3/) | | | |

1/ As used by the Cotton Branch, Production and Marketing Administration, Bakersfield, California. These indexes are used by the Cotton Branch in its periodic quality reports.

2/ Computed from Cotton Bulletin 1, and amendments, Commodity Credit Corporation, Production and Marketing Administration, August 16, 1949.

3/ No government loans are made on below-grade bales. In this study, below-grade cotton was assumed to have an average value of 11.84 cents per pound or 1685 points below Middling White, 15/16-inch staple length.